STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

PUBLICATIONS OF THE
DIVISION OF WATER RESOURCES
EDWARD HYATT, State Engineer

Reports on State Water Plan Prepared Pursuant to Chapter 832, Statutes of 1929

BULLETIN No. 31

PERMISSIBLE ANNUAL CHARGES

FOR

IRRIGATION WATER

IN UPPER SAN JOAQUIN VALLEY

A Cooperative Report by the College of Agriculture,
University of California.

1930

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LETTER OF TRANSMITTAL

MR. EDWARD HYATT,
State Engineer,
Sacramento, California.

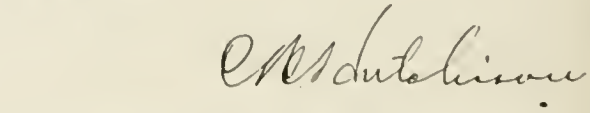
DEAR SIR: There is transmitted herewith a report entitled "Permissible Annual Charges for Irrigation Water in Upper San Joaquin Valley," by Frank Adams and Martin R. Huberty. Attached to this report, as Chapter VIII, is a report entitled, "Present Cost of Water to Irrigators in Upper San Joaquin Valley," by C. V. Givan and Jerald E. Christiansen.

This is one of two reports which you requested the College of Agriculture to prepare for you dealing with certain economic aspects of the State Water Plan.

You will recall that I appointed a committee from our staff to confer with you in connection with outlining the work, it being understood that this committee would also review the reports prior to their being forwarded to you.

This committee has completed the task assigned to it in connection with the accompanying report. It has approved this report as presenting a reasonable analysis of the problem of what the farmers of Upper San Joaquin Valley can afford to pay for irrigation water, and as furnishing a basis for answering the questions asked. It therefore recommends transmittal of the report to you.

Very sincerely yours,



Dean, College of Agriculture.

Berkeley, California.
October 30, 1930.

ACKNOWLEDGMENT

The writers acknowledge the very generous assistance of the Agricultural Extension Service of the College of Agriculture, rendered chiefly through Assistant State Leader L. B. Smith, Agricultural Extension Specialists L. W. Fluharty and H. R. Wellman, Farm Advisors W. E. Gilfillan, L. W. Taylor, J. P. Benson, and Wallace Sullivan, and Assistant Farm Advisors J. C. Johnston, N. D. Hudson and H. R. Keller; of the Farm Management Section of the College of Agriculture, through Professor R. L. Adams and L. A. Crawford; of the water committees of Tulare, Kern, and Kings counties; of the Division of Water Resources, State Department of Public Works, and of many individuals, including farmers, ranch owners or managers, and packing house managers, who have supplied information. The cost of production records obtained from the Agricultural Extension Service and from the Farm Management Section have been invaluable. Finally, the writers express their appreciation of the considerate criticisms and constructive suggestions made by members of the College of Agriculture advisory committee appointed by Dean C. B. Hutchison.

ORGANIZATION

STATE DEPARTMENT OF PUBLIC WORKS

B. B. Meek ..... *Director*

Edward Hyatt ..... *State Engineer*

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ORGANIZATION

UNIVERSITY OF CALIFORNIA, COLLEGE OF AGRICULTURE

Cooperating in Water Resources Investigation

C. B. HUTCHISON.....*Dean, College of Agriculture*

This report was prepared by

FRANK ADAMS,
Professor of Irrigation Investigations and Practice,

and

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with the advice and cooperation of the following committee appointed by the Dean of the College of Agriculture:

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Assistant State Leader, Agricultural Extension Service

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CHAPTER 832, STATUTES OF 1929

An act making an appropriation for work of exploration, investigation and preliminary plans in furtherance of a coordinated plan for the conservation, development, and utilization of the water resources of California including the Santa Ana river, Mojave river and all water resources of southern California.

[I object to the item of $450,000.00 in section 1 and reduce the amount to $390,000.00. With this reduction I approve the bill. Dated June 17, 1929. C C. YOUNG, Governor.]

The people of the State of California do enact as follows:

SECTION 1. Out of any money in the state treasury not otherwise appropriated, the sum of four hundred fifty thousand dollars, or so much thereof as may be necessary, is hereby appropriated to be expended by the state department of public works in accordance with law in conducting work of exploration, investigation and preliminary plans in furtherance of a coordinated plan for the conservation, development and utilization of the water resources of California including the Santa Ana river and its tributaries, the Mojave river and its tributaries, and all other water resources of southern California.

SEC. 2. The department of public works, subject to the other provisions of this act, is empowered to expend any portion of the appropriation herein provided for the purposes of this act, in cooperation with the government of the United States of America or in cooperation with political subdivisions of the State of California; and for the purpose of such cooperation is hereby authorized to draw its claim upon said appropriation in favor of the United States of America or the appropriate agency thereof for the payment of the cost of such portion of said cooperative work as may be determined by the department of public works.

SEC. 3. Upon the sale of any bonds of this state hereafter authorized to be issued to be expended for any one or more of the purposes for which any part of the appropriation herein provided may have been expended, the amount so expended from the appropriation herein provided shall be returned into the general fund of the state treasury out of the proceeds first derived from the sale of said bonds.

FOREWORD

This report is one of a series of bulletins on the State Water Plan issued by the Division of Water Resources pursuant to provisions of Chapter 832, Statutes of 1929, directing further investigations of the water resources of California. The series includes Bulletin Nos. 25 to 36, inclusive. Bulletin No. 25, "Report to Legislature of 1931 on State Water Plan," is a summary report of the entire investigation.

Prior to the studies carried out under this act, the water resources investigation had been in progress more or less continuously since 1921 under several statutory enactments. The results of the earlier work have been published as Bulletin Nos. 3, 4, 5, 6, 9, 11, 12, 13, 14, 19 and 20 of the former Division of Engineering and Irrigation, Nos. 5, 6 and 7 of the former Division of Water Rights, and Nos. 22 and 24 of the Division of Water Resources.

This bulletin is one of two reports dealing with certain economic aspects of the State Water Plan prepared cooperatively by the College of Agriculture, University of California.

The price which land owners in the upper San Joaquin Valley can afford to pay for irrigation water is recognized as a matter worthy of serious consideration. This report presents an analysis of the problem, together with conclusions on the amount that might be charged annually for irrigation water at the land for the more important crops grown in the upper San Joaquin Valley.

CHAPTER I

INTRODUCTION AND SUMMARY

This report presents the results of an investigation to determine how much the landowners of the upper San Joaquin Valley can afford to pay for such irrigation water as may be imported into that area under the proposed state plan of water conservation.

In undertaking this investigation it was decided to approach the problem primarily from the standpoint of cost of production and farm income, with such consideration of crop adaptability as the time available for the study would permit. A large amount of material relating to costs of production, yields and prices was known to be available from the enterprise efficiency studies of the Agricultural Extension Service of the College of Agriculture, as well as in the Farm Management Section of the College of Agriculture. Having been assured the full cooperation of these agencies, it was decided that the first steps would be to assemble and study this available material and to gather such additional information as might be possible through field investigations.

Realizing that what the landowners are now paying for irrigation water would throw light on the question under investigation, information already available as to present costs of irrigation water was assembled and a special field study made in the four upper counties of the valley with a view to obtaining additional data. The results of this latter study are contained in Chapter VIII. It is, of course, recognized that present irrigation water costs are, in many cases, either less or more than is justified, and therefore are not always a satisfactory measure of a "permissible" charge.

Method of Procedure.

The detailed procedure followed in the investigation has been (1) to ascertain the costs of producing and harvesting the principal crops grown in the upper San Joaquin Valley, without including interest on the average investment or a charge for irrigation water; (2) to estimate the farm income on the basis of probable yields and prices; (3) to compute interest on the average investment at 6 per cent per annum, and (4) from the foregoing to ascertain the margin remaining, after covering the costs of producing and harvesting the crop, together with interest at 6 per cent per annum. It has been assumed that this amount will be available for payments for irrigation water and additional profits over interest.

The data gathered are most complete for oranges, deciduous fruits, grapes, and cotton. For each of these crops charts have been prepared from which the amount available above the costs of producing and harvesting the crop and interest at 6 per cent can be readily computed. For the other crops included in the study, i.e., alfalfa, grain and miscellaneous crops, the presentation is less complete, but sufficient data are believed to be included to warrant a conclusion regarding the amounts that might reasonably be paid for irrigation water.

Table 1 shows the excess of farm income over the costs of producing and harvesting the crops considered, together with interest on the average investment at 6 per cent per annum; also the amounts it is believed can reasonably be paid for irrigation water.

The costs considered permissible are for a full supply of water delivered at the land on which it is to be used, and are therefore intended to include all such items as interest and principal payments on necessary capital expenditures for irrigation works and water supply, costs of maintenance and operation of irrigation works, as ordinarily understood, and supplemental pumping.

It is not suggested that none of the growers in the upper San Joaquin Valley can pay higher irrigation charges for the different crops studied than are arrived at herein. Some, of course, produce more than others, and there are wide differences in the efficiency of growers, types of farm enterprises, amount of working capital available, and the numerous other factors that determine cost of production and farm income. Neither is it suggested that the charges proposed can be paid by all of the growers, this also being because of the differences mentioned above. The permissible charges suggested are intended to be base charges which will be assessed in accordance with the earning capacity of the land; that is, on a benefit or ad valorem basis.

The extent of the water emergency in the upper San Joaquin Valley has not been taken into consideration in this investigation. Consequently, no attempt has been made to determine what the growers can pay for water in order to save investments which would be lost or placed in jeopardy without importation of an additional water supply. Those matters were considered outside of the realm of the investigation.

TABLE 1

SUMMARY OF DATA SHOWING EXCESS OF ESTIMATED FARM INCOME OVER COSTS PER ACRE OF PRODUCING THE PRINCIPAL CROPS GROWN IN THE UPPER SAN JOAQUIN VALLEY, PLUS INTEREST ON THE AVERAGE INVESTMENT AT 6 PER CENT PER ANNUM, TOGETHER WITH RECOMMENDED PERMISSIBLE ANNUAL COSTS FOR IRRIGATION WATER[1]

Crop	Excess of income over costs and interest	Recommended permissible annual cost of irrigation water
Oranges	$34 10	$30 00
Deciduous fruits	9 80	7 50
Grapes, more common varieties	7 75	5 00
Grapes, more profitable table varieties	[2]	7 50
Grain, Tulare Lake lands only	[2]	6 00
Cotton	14 50	7 50
Alfalfa	13 00	8 00
Miscellaneous crops	[2]	5 00

[1] Irrigation water is not included in costs of production. For basis on which farm income has been estimated see statements regarding each crop or group of crops considered.

[2] Determined only generally; see text.

Since what seems to be reasonable permissible costs (which in each case are less than the excess of farm income over the costs of producing and harvesting the crop, together with interest on the average investment), have been suggested, it seems desirable to state the reasons on which the conclusions expressed are based.

Oranges.—Although it is believed Plate I reasonably fixes the general magnitude of permissible irrigation water charges of the average grower of oranges in the Tulare citrus belt at about $35 an acre, the outlook for the maintenance of the relatively high average price of the past fifteen years is not encouraging.

This is due to the increased competition from oranges and grapefruit from Florida and Texas at the time when the Tulare citrus belt navels are harvested.

Deciduous Fruits.—The wide adaptability of California to the growth of deciduous fruits and the fact that a very large number of the farmers of the state desire to grow them, gives assurance that, unless conditions radically change in the future, the acreage in deciduous fruits will constantly tend to approach what might be called the saturation point. Furthermore, the cost-of-production data presented relate in the main to only one of the deciduous fruits and sufficient information is not available for other deciduous fruits to justify other than a conservative irrigation water charge. Admittedly, the difference between the indicated excess of farm income over costs and the permissible charge suggested is not large enough to be significant, in view of the large number of items that enter into the cost of production and harvesting of deciduous fruits. Therefore the conclusions of the report are but a conservative application of the results of the analysis presented.

Undoubtedly, many of the better growers of deciduous fruits will be willing to incur an annual cost of $15 or $20 an acre, but these are not believed to be safe figures for state planning. If, however, the owners of good deciduous fruit orchards are willing to assume an obligation to pay for irrigation water at the rate of $10 per acre per year, it is the conclusion of the report that the state, or other responsible authorities, would be justified in accepting the contract.

Grapes.—As in the case of deciduous fruits, it seems probable that the acreage in grapes will constantly tend to exceed that which will permit a large profit to the grower and a conservative permissible irrigation cost is required.

Cotton.—This is an annual crop grown largely on rented land and it is believed that, in the long run, cotton growing will not be attractive unless it gives prospects of substantial income per acre in excess of the necessary annual outlay.

Alfalfa.—This is one of the most widely grown crops in California and is likely to remain so. Present costs as high as $10 an acre on the good land are not at all uncommon among growers who are successful and of course there are large areas in alfalfa that are now paying more than that. For an average, or base, however, which will be less than justified for the better lands and too much for the poorer lands in alfalfa, a figure of $8 is suggested. Even $8 will seem to some too high for a base permissible cost for this crop. In this connection it should be remembered that the upper San Joaquin Valley is very favorably situated with reference to the large population centers of southern California.

It must be recognized that the cost of irrigation water for established areas can be higher than for projects in the making, that is, if the

lands not in crop or still in low production must pay for water on the same or approximately the same basis as lands in full or approximately full production. All of the costs suggested in the above table are for land in established production.

One crop of some importance in upper San Joaquin Valley, viz olives, is not covered in the above summary and no data regarding the cost of producing this crop, or its income, have been given. On the basis of general information only, which classes the olive with such plantings as Emperor grapes and some citrus, a figure of $10 per acre per year is suggested as a permissible irrigation water charge. Only the better varieties of olives could reasonably be classed with citrus fruits and for that reason the water cost suggested is much below that for citrus.

CHAPTER II

NATURE OF THE PROBLEM UNDER INVESTIGATION

Complexities in Analyzing Data.

What the landowner can afford to pay for irrigation water must always be relative, because of the many factors involved, each of which in turn bears some direct or indirect relation to some one or all of the others.

For instance, such questions as the type of the farm enterprise and its size, the knowledge and ability of the farmer, the working capital he has available and the extent of his indebtedness—all of which are more or less personal or individual to the grower—very definitely affect the amount he can pay for irrigation water. Again, this amount may depend on how much he spends for plowing and cultivating; for pruning, fertilizing and pest control; for state, county and other taxes; for harvesting and marketing, etc., since all or most of these factors may affect not only the cost of production, but also the yield and hence the farm income.

The changing relation between the value of land and the cost of irrigation water introduces another element of uncertainty. This, however, is not a matter which can be arbitrarily determined through the fixing of water charges. It is obvious the water necessary to make lands produce is as essential as the soil; and that since there is a certain maximum price for any given production which a farmer can afford to pay for land and water together, which price he can not exceed without loss, the price of either the land or the water separately must ultimately be governed by the price of the other.

In other words, as the cost of providing irrigation water increases, the amount farmers can safely pay for land correspondingly decreases, or at least must decrease if the investment is to be economical. Low irrigation costs encourage development, just as high irrigation costs retard it. While sensing these facts, the continuance of what might, over a period of years, be considered normal land prices, i. e., prices that do not reflect the present depression in agriculture, has been assumed in the study. The conclusion can not be escaped, however, that under the unusually favorable climatic and market conditions of the upper San Joaquin Valley, the price of land will be affected adversely by the necessary cost of irrigation water much more in the future than it has been in the past, due to the increasing demand for and the increasing cost of the latter. By this means, even if the irrigation water costs appreciably exceed those arrived at in this report, the better lands, if capable of growing products of high value and high demand, will be kept in production.

The suggestion has been made that it is not possible to separate a "permissible" irrigation water charge from the other items in the cost of producing a farm crop; that an increase or decrease in any of the important items of cost would increase or decrease what the farmer can afford to pay for irrigation water by the amount of the cost fluctuations.

Granting this separation of the "permissible" water charge from the other cost items presents difficulties, the writers believe such separation is nevertheless feasible, provided the total of the other items of cost can be reasonably determined from the data available. It is believed such is the case and the study has proceeded accordingly.

Interpretation of Data.

It is clear from what has been stated above that the variation in cost of producing the crops grown in the upper San Joaquin Valley is wide, and that, due to this variation, what one farmer can afford to pay for water with any given yield and price may be more or less than another can pay, with the same yield and price. It may be stated further that one whose cost of production is higher than that of others may still be able to pay a higher water charge because the higher cost of production may be due to better farming practice which results in better yields. These difficulties can not all be given mathematically correct weight in the present study, because the data are not sufficiently complete to permit the correlation. Nor, considering that to a large extent estimates are being dealt with, does this seem necessary for reaching a practical answer to the question under consideration. The endeavor has been made to meet these difficulties by using costs of production which seem to represent good practice. Although termed "average" costs in the report, they are not always strictly the arithmetical average of the individual records used, because personal judgment has influenced choice of the costs decided on as correct for use in this study.

It might be argued that permissible irrigation charges based on costs of production under "good practice," whether these costs are the average or above or below the average, will be excessive for those whose costs are higher. According to this thought, for instance, if the costs used were the median of the records studied and farm income, were always directly related to farm costs, the charge would be too high for half of the farmers. The point is, however, that costs of production and farm income are not always directly related. Higher costs may result from better practices, which, in turn, bring higher yields. On the other hand, lower production costs, because some important operation has been eliminated or curtailed, may reduce the income. In any event, a certain proportion of those whose costs of production are higher than the costs used will have incomes sufficiently increased through higher yields to permit the irrigation charge suggested and still cover the allowance for depreciation and for interest on the values of the land assumed in the report. Therefore, more farmers than those whose costs of production do not exceed the figures used in the analysis will be able to pay the irrigation charges suggested without hardship.

If costs of production are higher without any compensating increase in yield, the permissible charges suggested will be too great for the particular individuals concerned. These charges could not be paid without encroaching upon the allowance for depreciation and interest, unless the excess is covered by the differences between the total margin of the farm income above all costs and the permissible irrigation charges suggested. If, however, the plight of these farmers were due to poorer

quality of soil, they could be put on a relative parity with those better situated by assessing the charges in accordance with the earning capacity of the land; that is, on a benefit or ad valorem basis. It is assumed in this report that that procedure will be followed. If the inability of the farmers to meet the payment suggested is due to their poor managerial ability, lack of capital, or other causes not inherent in the soil, it is obvious ad valorem or benefit assessments would not give them relief.

Just as personal judgment has entered partly into decisions as to what constitute normal costs of production and harvesting, the figures as to farm income have been based only partly on historical averages of yields and prices. For the latter, the best available collective judgment as to the yields and prices on which the several crops may be expected to be stabilized in the future has in some cases been substituted, the procedure followed depending on the economic outlook for each particular crop. In this way an effort has been made to ascertain, for the principal crops grown in the upper San Joaquin Valley, the extent to which the farm income may be expected to exceed the cost of the items, other than irrigation water, which make up the cost of producing and harvesting the crop.

Obviously, all of this excess above farm costs is not available for paying for irrigation water if the farm is to be a successful business enterprise. The enterprise certainly would not be considered satisfactory if, in addition to the costs of production and harvesting, interest could not be paid on the farm investment. The amount necessary for this has therefore been indicated in the case of each crop, using a rate of 6 per cent per annum. The remainder left after paying interest represents that available for meeting the cost of irrigation water and for profits above interest.

How much of this final margin above costs and interest the landowners can pay for irrigation water is largely a matter of individual or collective judgment. Although conclusions regarding this have been reached, the essential available facts have been presented in such form as will assist those whose judgment is different to reach their own conclusions. It is quite possible many farmers would be willing to pay for irrigation water to the full extent of the amount remaining after meeting all costs of production and harvesting, together with interest at 6 per cent per annum, and some probably would be willing to pay more in order to save existing investments. The attitude of the landowners as to what they are willing to pay has not, however, been considered in the investigation, although it is realized this ultimately will be a major factor in the problem.

Procedure in Gathering Data

Agriculture in the four counties of the upper San Joaquin Valley is highly diversified. The crops grown include nearly all of those found in California, except a few of the sub-tropical fruits and some of the important truck crops not yet commercially established in the area. From the standpoint of investment and gross returns per acre, citrus fruits head the list, but the area is a favorable one for other crops at present yielding a relatively high return per acre, such as Emperor grapes, early shipping varieties of grapes, and peaches and early truck

crops. Along with these crops, of course, go others generally yielding a lower gross income, such as the more common varieties of grapes, deciduous fruits, alfalfa, cotton, grain, and miscellaneous field crops.

The first step in the present study was to assemble or gather for the more representative or more important crops grown in the areas the following data:

1. Cost of producing and harvesting the crop, not including the cost of irrigation water or interest on the farm investment.

2. The usual range of yield and price.

3. Present irrigation water costs, including both gravity and pumped supplies.

4. The general adaptability of the crop to the lands of the area, and the outlook.

Costs of Production.—These have been obtained most largely from the Agricultural Extension Service of the College of Agriculture, but also from the Farm Management Section of the College of Agriculture and directly from a large number of growers; also, in the case of citrus fruits, from the California Citrus League. Information obtained from the Agricultural Extension Service was gathered by the county farm advisors in connection with their enterprise efficiency studies.

In collecting their records the county farm advisors selected grower cooperators whom they supplied with the necessary blanks and who submitted monthly reports of all costs for both labor and materials. The data in these records have been retabulated in order to eliminate interest on the investment and costs of irrigation water, the latter including assessments, water tolls, interest and depreciation on pumping equipment, or one or more of these items.

Information supplied by the Farm Management Section is in the form of general figures and represents its conclusions as to production costs from long observation and field study. The material supplied by the California Citrus League was obtained by that organization through personal interviews with growers over a four-year period.

Yields and Prices.—The enterprise efficiency studies of the Agricultural Extension Service show both yields and prices, and its figures, as well as others gathered from packing houses and other sources, have been used to arrive at a range within which variation may normally occur. The ranges taken into consideration in this report do not include either maximum or minimum figures, but are sufficiently wide to cover the usual cases. The lower figures represent conditions under which the cost of production is greater than the income, while the higher figures represent yields and prices well above the average, but not exceptional.

Present Irrigation Water Costs.—Except in the case of irrigation districts, for which information is on file in the office of the State Engineer, present irrigation water costs have been obtained through field investigation. In the case of companies, it has been usual to obtain desired records from the secretaries and superintendents. Where desired information was not on record in the office of the companies, the best estimates possible were obtained. A majority of the companies furnish

mainly gravity water, but under most of the gravity systems supplemental pumping by the individual landowners is the usual practice, and it has not always been possible to arrive at a satisfactory figure of total costs to the farmer. Costs under pumping systems have been obtained by combining power costs with interest, depreciation and taxes on the wells and pumping equipment, power charges being furnished by the power companies supplying the service. The investigations of present water costs have included all of the active irrigation districts in the foothill belt and most of the companies supplying irrigation water in the three upper counties of San Joaquin Valley, as well as individual pumping plants on 44 holdings. The latter, however, represents but a small percentage of the total number of irrigation pumping plants in Fresno, Tulare, Kings, and Kern counties and can only be considered as examples taken more or less at random.

Although the complete data gathered regarding present irrigation costs are set forth in Chapter VIII, frequent reference to the material is made in other chapters.

Bases on Which Costs of Production Have Been Computed.

There is not always agreement as to what items should be included in determining costs of producing farm crops. The practice of farm management specialists has been followed in the main, and, in addition to labor and materials, the following have been included:

Depreciation on improvements, other than dwellings and irrigation wells; depreciation on equipment, other than pumping plants; depreciation on permanent plantings; taxes and insurance, and an allowance for general expenses amounting to from 5 to 10 per cent of the costs of all labor and materials used.

The cost of irrigation water has not been included, since determination of that item has been the purpose of the inquiry, nor has interest on the farm investment been considered as part of the cost of production. The amount needed to cover the latter has been stated, however, for each crop considered.

The position is not taken in this report that interest on the farm investment is not a legitimate item in the cost of producing a farm crop. It may or may not be earned, however, and if not earned can not be paid. Since it obviously comes, if at all, after other costs are paid and since many farm enterprises continue in operation year after year without returning any "net" above the actual cash outlay, the labor income to the operator and depreciation, the procedure of determining reasonable charges for irrigation water on the basis of cost of production and farm income is simplified by leaving interest out of that cost. As previously stated, however, the presentations which follow show what is necessary to cover interest.

Among other items not included is interest on working capital, whether owned or borrowed. This is admittedly a necessary part of the cost of production, but farm management records do not customarily include it and no satisfactory basis is available for determining or estimating what would be proper figures to use.

The custom of including an allowance in the cost of production for the usual going wage for the time of the owner or operator devoted to the farming operations has been followed. This means that the actual

cash outlay may be less than the cost given. No allowance has been made for superintendence by the individual farm operator, the inclusion of this not being usual in such studies.

The rate of depreciation of plantings is an item on which there is not always an agreement among students of farm management. The Agricultural Extension Service assumed a life of 40 years * for citrus trees and has written off depreciation of the trees at the rate of $31 an acre each year, beginning with the tenth year.† They further assumed a cost of approximately $1,000 an acre, exclusive of land, for bringing a citrus grove to ten years of age, this being the net cost after crediting income. These figures have been accepted in this study of reasonable irrigation charges for citrus fruits in the upper San Joaquin Valley, although it is known that in some cases the life of citrus groves is considerably more or less than 40 years and that there is considerable variation in the cost of growing the trees. Depreciation of citrus trees at the rate of $31 an acre is one of the large items in the cost of production of that crop and in practice might not be justified.

Depreciation of improvements and equipment has been computed by the farm advisors largely on the basis of the owners' estimates of present value and length of life. Their figures have been accepted for their records. Where costs have been determined through direct contact with growers, rather than from data gathered by others, depreciation has been computed at the following rates:

Buildings, 5 per cent; irrigation pipelines, 4 per cent, and farm equipment, 15 per cent.

This report of course is not directly concerned with farm profits, excepting as interest may be considered in that category, as it is by some, and excepting as they determine broadly the economic condition of any particular branch of agriculture and thus fix the general scale of production expenditures, including the expenditure for irrigation water. Incidentally, however, the tables and charts which follow are so set up as to indicate profits within the yield and price ranges used when income is large enough to return a profit.

Correlation of Cost of Irrigation Water With Other Production Costs.

While it has not been usual in economic and engineering studies to attempt to show any relationship between costs of irrigation water and other farming costs, the former sometimes have been expressed in the past as percentages of the gross farm income and in other cases as percentages of the net farm income. There is some justification for such an attempted correlation because, broadly speaking, the amount that reasonably can be paid for irrigation water is determined by the value of the products grown and by the profits to the grower. The chief difficulty in attempting such a correlation, however, is found in the wide variation in harvest costs. At any rate, it was felt that the number

* Since completion of the computations for this report the Agricultural Extension Service has extended the assumed life of orange groves in the Tulare citrus belt to 45 years to conform to its assumptions for southern California. This, however, would not materially alter the figures in the report.

† It has been suggested that the preferable procedure for computing depreciation is the "sinking fund" instead of the "straight-line" method. Since the sinking fund deposit and interest on the entire investment together do not vary widely from the straight-line depreciation and interest on "average investment," and since the latter method is adopted in all of the Agricultural Extension Service records used, it is used in this report.

of examples available in the present study was not sufficient to justify attempting such a correlation. When available data permitted, however, the cost of irrigation water has been expressed as a percentage of pre-harvest labor and material costs, since, for any given crop and for any standard of cultural practice, the latter are generally independent of other factors. Only in the case of citrus fruits has this been done.

Crops Considered in the Study.

As previously indicated, the agriculture of the upper San Joaquin Valley is highly diversified, but it has seemed neither necessary nor desirable to attempt in this study to cover all of the crops. What has been done has been to consider those crops or groups of crops which represent the principal branches of production. These are citrus fruits, deciduous fruits, grapes, grain, cotton, alfalfa, and miscellaneous field crops.

CHAPTER III

CITRUS FRUITS

Costs of Production.

The citrus area of the San Joaquin Valley, generally referred to as the interior citrus area or the Tulare citrus belt, extends south along the eastern plains and foothills from the vicinity of Kings River through Fresno, Tulare, and Kern counties to Edison, a few miles east of Bakersfield, and out onto the valley floor in Fresno County near Dinuba and Reedley. The citrus belt is not continuous, excepting most of the way along the belt in Tulare County. The present study covered groves near Orange Cove and Reedley in Fresno County; near Exeter, Lindsay, Strathmore, Porterville, Terra Bella, and Ducor in Tulare County, and at Edison in Kern County.

Including fourteen cost-of-production records prepared by the assistant farm advisor of Tulare County, data were obtained directly from 22 individual groves and one group of groves containing 129 acres. The total area represented by these 23 records was 504 acres, of which 250 acres were in Washington Navel oranges, 125 acres in Valencias, and 129 in Navels and Valencias, unsegregated. This is, of course, only a small percentage of the total citrus area in the San Joaquin Valley. In addition, a four-year record was supplied by the California Citrus League, this covering the cost of production for Navels on approximately 100 groves, representing an area of from 2500 to 3000 acres each year.

Of the 39,000 acres now in citrus plantings in the Fresno-Tulare-Kern area, more than 60 per cent is in Navels and about 30 per cent in Valencias. Because of this preponderance of Navels, and further because, for the purposes of this report, differences between production costs of the two varieties do not appear to be significant, Navels have been chiefly considered in this study and the conclusions reached are based largely on that crop. Valencias entail an additional cost for frost protection which, although considered desirable for Navels to an extent that will permit prolonging the harvest into the frost season, is not usually practiced with this variety. However, as will appear later, the tendency toward partial frost protection in the Navel areas has influenced the decision as to what may properly be assumed to be the pre-harvest production cost.

Table 2 has been made up from the cost-of-production data furnished by the assistant farm advisor of Tulare County or obtained by the writers during the field enquiry.

It will be noted that, omitting the records for the three largest acreages, the average pre-harvest cost shown in the above table is $171.91 an acre. Including the three largest acreages reduces this to $167.16 an acre. There are five records showing pre-harvest costs less than $150 and one of more than $200. Eliminating these, which are unusual, leaves seventeen between $160 and $200. Averaging these seventeen records gives $176.85.

The Citrus League records for Navel oranges, referred to above, are available for the years 1925, 1926, 1927 and 1928. Omitting from these

records items for irrigation water and superintendence,* neither of which is included in the costs listed in Table 2, but adding the same amount for depreciation of trees that is allowed in Table 2, gives a range in average pre-harvest costs, not including interest or irrigation water, of from $185.63 to $204.85 an acre, with a mean of $192.39.†

The difference between the cost of production, as shown in Table 2, and the costs obtained by the Citrus League is not significant in view of the large number of variable items entering into records of this kind. The lower average costs obtained from the enterprise efficiency studies of the Agricultural Extension Service and from the records obtained in the field, while probably substantially correct for the particular growers involved, presumably are not nearly as representative of the whole citrus industry of the Tulare-Fresno-Kern belt as is the average of the records obtained by the Citrus League. This is perhaps mainly due to the larger number of the latter and to the further fact that an attempt was made by the Citrus League to include the different grades of groves in approximately the same proportion as they occur in the field. Various other suggestions have been advanced as to the reason for the differences in the two sets of figures, but, as a matter of fact, the figures obtained from the several different sources are of the same general order or class and the choice of which to accept becomes mainly a matter of the degree of conservatism that is to govern conclusions.

There is a general tendency in the Tulare citrus industry toward better cultural methods, and the use of additional fertilizers is being strongly recommended. Furthermore, there is a feeling in the industry in this area that in order to permit more orderly marketing of the Navel crop, frost protection must be provided for at least a portion of the Navel area instead of harvesting it all before the frost period of early winter. The tendency is thus toward increasing instead of decreasing the cost of production. Bearing these facts in mind it has been thought proper, on the basis of cost-of-production figures presented, to assume a pre-harvest cost for Navel oranges in the Tulare citrus belt of $190 an acre, exclusive of interest and the cost of irrigation water, and hereafter, in this report, that figure will be used.

In order to determine the difference between the income to the growers and their total cost, it is necessary to add to the pre-harvest cost the cost of picking and hauling to the packing houses. Harvest costs of citrus fruits obviously increase with increase in yields. There was a general agreement in the field that, for the purposes of this study, these costs, including picking and delivering to the packing house, may be taken to be 24 cents a packed box.§ Using this figure

* Mr. F. O. Wallenkampf, secretary of the California Citrus League, states that items in their costs is intended to cover actual out-of-door work in supervising ranch operations. It averages $8.40 for the four years, 1925 to 1928.

† The average yields for the orchards to which these cost-of-production figures apply was 146.4 packed boxes per acre, as against 128.4 packed boxes per acre for the longer period covered by Table 4. No data are available to indicate whether the higher average is a reflection of higher costs of production.

§ This is somewhat higher than the average shown in the available statistics, although the average shown by the 1929 summary of enterprise efficiency studies in Tulare County is 22.2 cents. It is recognized that the harvest costs per box are not constant, regardless of yield, but it is believed to be approximately constant in the zone considered significant in this study, that is, say from 25 per cent below to 25 per cent above the average. Data were not available for correcting for high and low yields.

TABLE 2

COST PER ACRE OF PRODUCING ORANGES IN FRESNO, TULARE AND KERN COUNTIES WITHOUT ALLOWANCE FOR INTEREST OR FOR IRRIGATION WATER. THE TOTALS FOR PRE-HARVEST COST AND FIXED CHARGES INCLUDE DEPRECIATION ON TREES AT THE RATE OF $31 AN ACRE EACH YEAR.

Cost of irrigation water shown as percentage of pre-harvest labor and material costs

Serial number	Variety	Area in acres	Pre-harvest labor and materials	Depreciation		Taxes and insurance	Allowance for general expenses	Total pre-harvest cost and fixed charges	Cost of water as per cent of pre-harvest labor and materials
				Improvements	Equipment				
1	Navels	13 00	$114 00	$2 07	$11 59	$4 00	*$5 70	$168 36	35
2	Navels and valencias	15 00	97 40	2 95	7 50	2 66	*4 87	153 38	45
3	Valencias	107 00	65 02	3 52	4 20	7 72	*3 25	114 71	15
4	Navels	9 09	74 06	2 00	0	9 89	6 74	123 69	34
5	Navels	16 11	119 97	2 50	0	8 93	7 66	169 96	20
6	Navels	9 67	144 97	2 53	4 00	3 12	10 16	194 88	33
7	Navels	9 60	119 02	86	2 05	5 26	8 66	166 85	29
8	Navels and valencias	18 00	156 23	2 75	0	15 25	*7 81	213 10	42
9	Navels	17 63	129 75	3 49	12 87	7 81	11 14	196 06	25
10	Navels	10 00	126 25	2 20	0	6 00	*8 31	173 76	25
11	Navels	20 00	139 62	2 57	0	7 77	11 04	192 00	36
12	Navels	14 37	120 89	1 59	0	8 33	9 35	171 16	42
13	Navels	10 00	123 24	84	5 87	4 65	9 58	175 18	39
14	Navels	10 00	126 01	95	3 12	3 60	9 95	174 63	26
15	Navels	8 91	69 26	2 13	6 38	12 19	7 26	128 22	50
16	Navels	4 93	114 31	2 49	0	8 71	8 97	165 48	32
17	Navels	12 67	144 71	3 05	0	8 04	10 61	197 41	26
18	Navels	4 50	131 48	3 25	34	8 12	9 87	184 06	31
19	Navels	4 67	105 03	2 10	0	7 00	7 60	152 73	35
20	Valencias	10 00	135 00	1 26	0	8 50	*8 78	184 48	26
21	Navels	20 00	92 40	0	17 03	4 80	4 62	132 82	57
22	Navels	30 00	77 90	4 75	4 75	3 09	5 28	[1]126 77	83
23	Oranges	129 00		[2]	[2]	[2]	[2]	[1]185 10	
	Average, all records	21 92	$114 80			$7 38	[3]$8 92	$167 16	35
	Average, omitting three larger acreages							$171 91	

*Not figured on cost of harvesting.
[1] Average of three years.
[2] Included in total.
[3] Does not include groves for which allowance for general expenses was not figured in cost of harvesting.

and a pre-harvest cost of $190 an acre, Table 3 has been prepared to show the total cost, delivered at the packing house, for yields of 50 to 300 packed boxes an acre, yields above and below this range not being considered of importance in this study.

TABLE 3

AVERAGE COST PER ACRE OF PRODUCING AND HARVESTING NAVEL ORANGES IN FRESNO, TULARE AND KERN COUNTIES, SEGREGATED ACCORDING TO YIELD

Pre-harvest cost of production taken at $190 an acre. Harvesting figured at 24 cents a packed box

Yield in packed boxes per acre	Average cost per acre	Yield in packed boxes per acre	Average cost per acre
50	$202	200	318
75	208	225	344
100	214	250	250
125	220	275	256
150	226	300	262
175	232		

Yields and Prices of Navel Oranges.

The yield to be expected from the average groves and the price it is reasonable to count on over a period of years are both matters about which there may be disagreement. It is necessary nevertheless in this study to make definite assumptions for each. This has been done on the basis of the data presented in Tables 4 to 7, the advice of the farm advisor and assistant farm advisor of Tulare County and the Agricultural Outlook for 1930 published by the Agricultural Experiment Station.

TABLE 4

AVERAGE YIELD PER ACRE IN PACKED BOXES OF NAVEL ORANGES IN TULARE, FRESNO AND KERN COUNTIES, 1922-1927

1922	112.0
1923	112.2
1924	100.0
1925	154.3
1926	155.4
1927	155.1
1928	138.4
Average	138.4

Authority, California Citrus League

Yield.—If the data in Table 5 could be weighted to make them fully representative of the entire Tulare citrus belt, they might furnish satisfactory figures as to yield, prices, and return per acre to use in this study. Since only a portion of the citrus area is included and since the areas represented by the various packing houses are not proportionate to the total areas where conditions are similar, such weighting is not possible. Table 5 therefore, really becomes a tabulation of examples, geographically but not numerically representative. Table 6 shows variations occur not merely between localities but between individual growers.

The best available figures as to yield for Navel oranges are those from the California Citrus League, which are presented in Table 4 and which show an average for the years 1922 to 1928 of 138.4 packed boxes per

TABLE 5

AVERAGE YIELD OF NAVEL ORANGES IN PACKED BOXES PER ACRE, AVERAGE PRICE TO GROWER PER PACKED BOX AND AVERAGE RETURN PER ACRE IN THE INTERIOR CITRUS BELT, AS SHOWN BY RECORDS FROM TEN PACKING HOUSES IN FRESNO AND TULARE COUNTIES

Year	Packing house No. 1 (*750 acres)	Packing house No. 2 (303 acres)	Packing house No. 3 (1,474 acres)	Packing house No. 4 (389 acres)	Packing house No. 5 (565 acres)	Packing house No. 6 (575 acres)	Packing house No. 7 (306 acres)	Packing house No. 8 (438 acres)	Packing house No. 9 (521 acres)	Packing house No. 10 (1,212 acres)
Yield in packed boxes per acre										
1921							82.5	82 7		
1922					43 0		86.3	93 3		
1923				64.1			104.5	135.9		
1924	86 2	175.1		88.3	97.4		154 6	143 6		
1925	114 5	125.2	54.8	82 3	132.0		158.5	128.7	90.47	67 74
1926	139 0	111 0	49.8	57.4	114.2	131.9	146.9	158.1	83.23	69 98
1927	132 0	141 7	65.0	104 7	82.1	145.4	161.7	147.5	106 02	69 99
1928	67.8	163 1	80 6	112.1	135.6	139.6	173.1	136.3	114.12	76 59
1929		98 3	61.3	68.8					85.41	56 69
Price to grower per packed box										
1921							$2 81	$3 08		
1922			$1 55		$1 87		1 54	1 84		
1923			1 54	$1 26	1 29		1 28	1 15		
1924	$2 01	$1 73	2 35	1 86	2 34		2 02	2 12		
1925	2 98	2 91	2 46	2 27	2 80		2 38	2 60	$2 11	$2 44
1926	2 53	2 46	2 59	2 09	3 31	$3 19	3 09	2 95	2 31	2 98
1927	2 83	2 88	3 17	2 49	3 19	3 66	3 37	3 36	1 86	3 11
1928	3 24	2 46	2 90	2 27	3 09	3 20	2 63	2 69	1 56	2 82
1929		3 23	3 73	3 23	1 52				1 88	3 23
Average return per acre										
1921							$231 77	$254 72		
1922					$80 41		132 85	171 67		
1923				$80 79			134 22	156 29		
1924	$219 37	$302 92		161 32	227 92		312 67	304 43		
1925	335 69	364 32	$134 81	186 87	369 60		376 58	334 62	$190 92	$164 92
1926	349 71	273 06	128 98	120 05	378 00	$420 76	453 83	466 30	195 01	208 36
1927	436 13	408 10	206 05	260 68	261 90	532 16	545 49	495 60	197 05	217 79
1928	186 10	401 23	233 74	254 38	419 00	446 72	455 95	366 65	177 63	216 31
1929		317 51	228 65	222 32					160 95	183 08

*Includes both navels and valencias.

TABLE 6

VARIATION IN YIELD OF NAVEL ORANGES, AS SHOWN BY THE PRODUCTION RECORDS OF TWO PACKING HOUSES IN THE TULARE CITRUS BELT AND BY RECORDS FOR ALL CALIFORNIA CITRUS LOCALITIES

Range in yield, packed boxes per acre	Packing house No. 1[1] (1927-1928)	Packing house No. 2[1] (1925-1929)	California Citrus League
Less than 50	27	6	14
50 to 74	20	6	23
75 to 99	11	10	42
100 to 124	10	5	56
125 to 149	8	7	61
150 to 174	2	4	73
175 to 199	1	2	49
200 to 224	0	1	48
225 to 249	0	2	45
250 to 274	0	0	28
275 to 299	0	0	24
300 to 324	0	0	17
325 to 349	0	0	15
350 to 399	0	0	12
400 and over	0	0	14

[1] These packing houses are in areas of distinct water shortage. In packing house No. 2 some individual records were for less than the five-year period.

Authority, California Citrus League.

acre.* The citrus specialist attached to the Tulare County farm advisor's office expressed the opinion that, in view of the soil and climatic conditions of the area, the average yield does not exceed 135 packed boxes per acre, which is in substantial agreement with the Citrus League average.

Price.—As in the case of yields, the figures for prices presented in Table 5 are examples which show mainly geographical differences and are not susceptible of being reduced to satisfactory averages. Chief reliance for price data has therefore been placed on Table 7, made up from data supplied by Mr. Harry R. Wellman of the Agriculture Extension Service. This table shows the average price received by the California Fruit Growers' Exchange for Navel oranges during November, December, and January for the years 1914–15 to 1928–29 and also the average price received by the growers after deducting 70 cents per packed box for packing and 12 cents per packed box for district and central exchange charges and for advertising.† The range in average price is shown to be from 73 cents to $3.55 per packed box, with a mean of $2.19. This is 69 cents higher than the general average suggested by several authorities in the field as a safe basis for estimating the future. However, since the average is for a relatively long time and extends through periods of both low and high prices, it is felt acceptance of it as the basis of the estimates is justified.

Income to Citrus Growers and Amount Available for Water Charges.

Having reached the conclusion that, for the purposes of this report, it is reasonable to assume an average yield of Navel oranges of 138 packed boxes an acre and an average price to the grower of $2.19 a

* It might be noted that this average yield might have been higher if all groves had been furnished with an ample water supply. However, the areas that have not received sufficient water are relatively limited.

† The cost of packing oranges was estimated by one packing house at 60 cents per packed box, but the writers were advised by the Agricultural Extension Service that 70 cents is a safer figure to use in this report.

TABLE 7

AVERAGE f.o.b. PRICES PER PACKED BOX RECEIVED FOR NAVEL ORANGES IN TULARE CITRUS BELT BY THE CALIFORNIA FRUIT GROWERS EXCHANGE FOR NOVEMBER, DECEMBER AND JANUARY, 1914-15 TO 1928-29, AND AVERAGE PRICES RECEIVED BY THE GROWERS DURING THE SAME MONTHS AND YEARS.

After deducting 82 cents a packed box to cover packing house, exchange and advertising charges.

	F. O. B. to Exchange			Price to growers			
	November	December	January	November	December	January	Average for Nov., Dec., Jan.
1914-15	$1 97	$1 34	$1 33	$1 15	$0 52	$0 51	$0 73
1915-16	2 70	1 77	1 82	1 88	0 95	1 00	1 28
1916-17	2 28	1 49	1 60	1 46	0 67	0 78	0 97
1917-18	2 51	3 25	3 71	1 69	2 43	2 89	2 34
1918-19	4 06	3 59	3 09	3 24	2 77	2 27	2 76
1919-20	3 32	3 27	3 64	2 50	2 45	2 82	2 59
1920-21	3 56	2 39	2 43	2 74	1 57	1 61	1 97
1921-22	4 20	3 36	3 22	3 38	2 54	2 40	2 77
1922-23	3 08	2 63	2 56	2 26	1 81	1 74	1 94
1923-24	2 50	1 99	2 15	1 68	1 17	1 33	1 39
1924-25	2 99	3 32	3 10	2 17	2 50	2 28	2 32
1925-26	3 98	3 11	3 34	3 16	2 29	2 52	2 66
1926-27	4 31	3 49	3 55	3 49	2 67	2 67	2 73
1927-28	5 18	3 97	3 96	4 36	3 15	3 14	3 55
1928-29	3 72	3 53	3 01	2 90	2 71	2 19	2 56
Mean							$2 19

packed box during November, December, and January, the months of largest shipments, it now becomes necessary to compute or estimate the income to the growers and the amount that is available for irrigation water. To assist in this, Tables 8 and 9 and Plate 1 have been prepared.

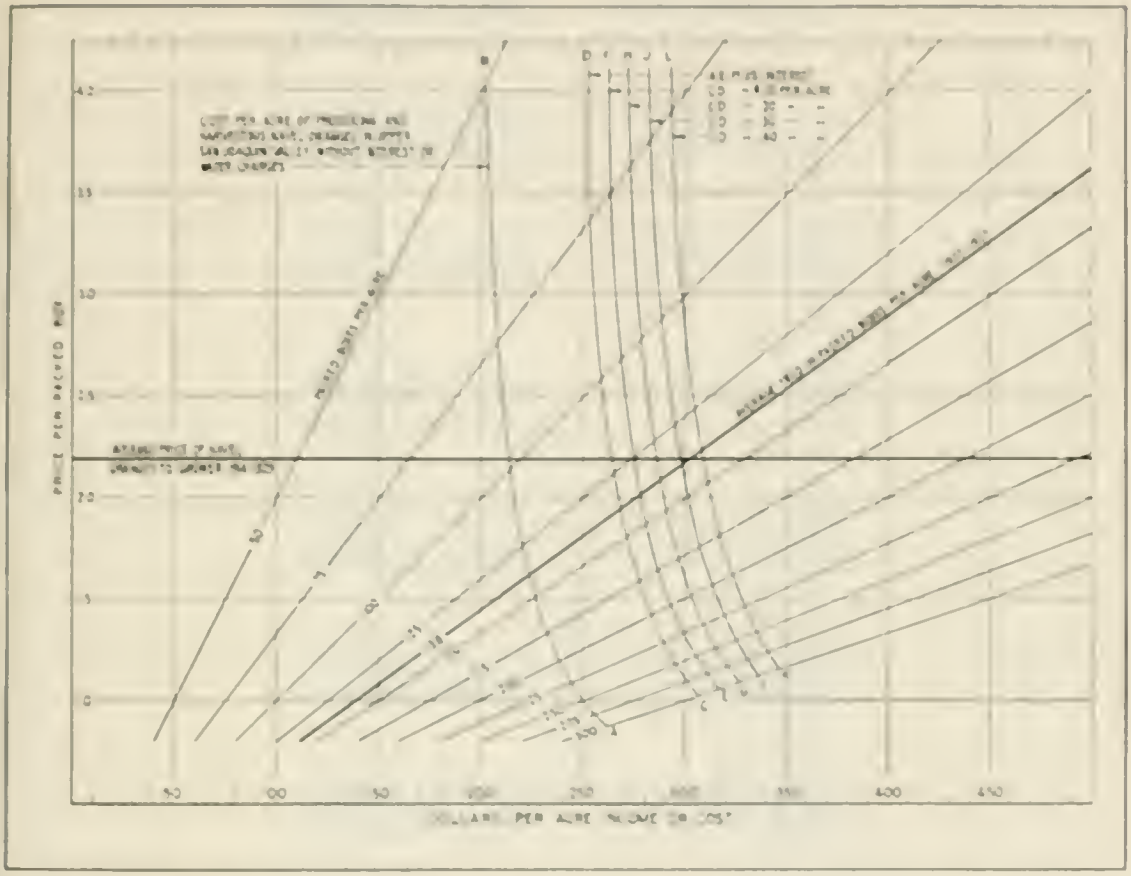
Table 8 shows the income to growers of Navel oranges with prices varying from $1 to $3.50 a packed box and with yields varying from 50 to 300 packed boxes an acre. Table 9 shows the income available for payment of irrigation water charges, interest on investment, and profits, after paying the pre-harvest costs of production at the rate of $190 per acre and harvest costs at the rate of 24 cents a packed box for picking and hauling to the packing house.

Plate 1 graphically presents the income to growers with varying prices and yields and the price necessary with certain given yields to meet (1) the cost of producing and harvesting Navel oranges in the Tulare citrus belt, not including interest on the farm investment or irrigation water; (2) the cost of producing and harvesting including interest on the investment, but not irrigation water, and (3) the income necessary to pay any given charge for irrigation water, or profits, in addition to the costs of production and harvesting and interest.

Interest on the investment is computed at the rate of 6 per cent on an average valuation of $750 an acre, which includes trees at $500 per acre; land, $150; equipment, $50, and irrigation pipe and other improvements, $50.*

* The average value of $500 for the trees is half the total assumed net investment in carrying an orange grove through the first ten years. Interest on the money spent during the first ten years is included in this $1,000. This figure is generally accepted by authorities.

PLATE I



RELATION BETWEEN COST OF PRODUCING AND HARVESTING NAVEL ORANGES AND FARM INCOME

The curved line *AB* in the chart represents the cost of producing and harvesting Navel oranges in the Tulare citrus belt, and the line *CD* represents that cost plus interest on the investment. Lines *EF*, *GH*, *IJ*, and *KL* indicate, in $10 increments, the additional cost, depending on the allowance for annual water charges, or the additional income needed to meet any given water charges or profits.

It will be noted from Plate I that with a yield of 138 boxes per acre and a price to the grower of $2.19 per packed box, the return per acre would pay pre-harvest costs of $190 an acre, harvest costs at 24 cents a packed box, interest at 6 per cent on an average investment of $750 an acre, and leave $34.10 an acre for irrigation water and additional profits over the labor income to the operator and the interest on the average investment.

Present Irrigation Costs in the Fresno-Tulare-Kern Foothill Belt.

The citrus areas in the Tulare citrus belt are very largely supplied with water by pumping, partly by irrigation district or small company systems and partly by individual pumping plants. In Chapter VIII the data regarding water costs gathered in irrigation districts in the foothill belt are set forth in Table 39, costs under water companies are given in Table 40, and under three private pumping plants in Table 41. The extent to which the cost of pumping varies with the capacity of the pumping plants, the lift and the quantity of water pumped, is indicated in Tables 37 and 38.

TABLE 8

GROSS INCOME PER ACRE TO GROWER FROM ORANGES IN THE TULARE CITRUS BELT, WITH NET PRICE TO GROWER OF $1 TO $3.50 PER PACKED BOX

Packed boxes per acre	Net prices to grower per packed box										
	$1.00	$1.25	$1.50	$1 75	$2 00	$2.25	$2.50	$2.75	$3 00	$3.25	$3 50
	Resultant income per acre										
50	$50 00	$62 50	$75 00	$87 50	$100 00	$112 50	$125 00	$137 50	$150 00	$162 50	$175 00
75	75 00	93 75	112 50	131 25	150 00	168 75	187 50	206 25	225 00	243 75	262 50
100	100 00	125 00	150 00	175 00	200 00	225 00	250 00	275 00	300 00	325 00	350 00
125	125 00	156 25	187 50	218 75	250 00	281 25	312 50	343 75	375 00	406 25	437 50
150	150 00	187 50	225 00	262 50	300 00	337 50	375 00	412 50	450 00	487 50	525 00
175	175 00	218 75	262 50	306 25	350 00	393 75	437 50	481 25	525 00	568 75	612 50
200	200 00	250 00	300 00	350 00	400 00	450 00	500 00	550 00	600 00	650 00	700 00
225	225 00	281 25	337 50	393 75	450 00	506 50	562 50	618 75	675 00	731 25	787 50
250	250 00	312 50	375 00	437 50	500 00	562 50	625 00	687 50	750 00	812 50	875 00
275	275 00	343 75	412 50	481 25	550 00	618 75	687 50	756 25	825 00	893 75	962 50
300	300 00	375 00	450 00	525 00	600 00	675 00	750 00	825 00	900 00	975 00	1,050 00

TABLE 9

AMOUNTS PER ACRE AVAILABLE FROM ORANGES IN THE TULARE CITRUS BELT FOR PAYING FOR IRRIGATION WATER, INTEREST ON INVESTMENT AND PROFITS, WITH A PRICE RANGE OF $1 TO $3.50 PER PACKED BOX AND YIELDS OF 50 TO 300 PACKED BOXES PER ACRE

Costs Within Irrigation Districts.—There are three irrigation districts in the foothill belt, namely: Terra Bella, Vandalia, and Lindsay-Strathmore. The "usual" cost to irrigators, as set out in Table 39, ranges from $25 to $66 per acre per annum. The averages for the three districts are $35, $33 and $41, respectively. These averages are computed by adding the district water tolls to the district assessments, the former figure being computed by multiplying the water toll per acre-foot by the average water duty in the district. In addition to the averages for the districts, Table 39 gives the cost to thirteen individuals, these including both the district charges and the cost of supplemental pumping.

Costs Under Water Companies.—Table 40 includes data for eight companies as a whole and for five individuals under another company. Omitting the figures for one of the companies, which serves more deciduous and other crops, including pasture, than citrus, the costs per acre range from $27 to $62.

Costs Under Private Pumping Plants.—Data for only three farms are given in Table 41, the costs for these being $31, $34, and $30 per acre, respectively.

CHAPTER IV

DECIDUOUS FRUITS

Costs of Production.

Most of the data used in determining reasonable irrigation charges for deciduous fruits relate to peaches, for which there were 84 records made in Tulare County by the Agricultural Extension Service. Additional records were obtained from two large plantings and access was had to the estimates of the Farm Management Section of the College of Agriculture and to the budget of a bank operating a large number of farms in the San Joaquin Valley.

Peaches are one of the very important deciduous orchard crops of the San Joaquin Valley, as well as of California generally. They constitute one of the crops always likely to be on a highly competitive basis, so that growers in the long run will be prosperous only when their gross income is relatively high and their costs relatively low. While it is only in the fresh peach market that there is appreciable competition with other states, the fact has been brought out in the publications of the California Agricultural Experiment Station and other agencies that good cultural practices as well as good land are necessary if growers are to be successful.

Of the four upper San Joaquin Valley counties chiefly considered in this inquiry, Tulare County ranks second only to Fresno County in acreage devoted to peaches. These two counties, in fact, lead the state in the production of this crop when the principal varieties grown are considered. The acreages in peaches in the upper San Joaquin Valley in 1929, as reported by the California Cooperative Crop Reporting Service, gave Fresno County 15,212; Tulare County, 11,752; Kings County, 4931; Kern County, 1092.

The 84 records of production costs obtained through the Agricultural Extension Service included Phillip, Tuscan, Peak, Orange, Libbie, Pelora, Elberta, and Lavell. The larger number of records were for Phillip, Tuscan, and Peak, all clingstone varieties. One record was for 112 acres, one for 27 acres, and the remaining 82 ranged from 2 to 20 acres.

Table 10 gives the averages for the 84 records, omitting the detail for pre-harvest labor and material, which were not tabulated separately for this report. The trees were depreciated at the rate of $20 per acre per annum, based on an estimated investment of $280 an acre and depreciation from the seventh to the twentieth years. Depreciation of equipment does not include walls or pumping plants. Allowance for general expenses is at the rate of 5 per cent of all labor and material costs.

The total pre-harvest costs and fixed charges, of which $97.35 is the average, ranged from $48.05 to $155.94. Averaged by locations, the totals were:

Exeter, fourteen records, $121.76; Earlimart, one record, $107.42; Strathmore, seven records, $105.52; Visalia, nine records, $103.92; Tulare, three records, $94.16; Cutler, three records, $82.30; Farmersville, fourteen records, $73.25; Ivanhoe, six records, $61.25.

TABLE 10

AVERAGE OF 84 RECORDS OF PRE-HARVEST COST OF PRODUCTION OF PEACHES IN TULARE COUNTY, 1926, 1927, 1928, 1929

Includes fixed expenses, but not irrigation water or interest.

Ages 6 years or more.

Total area in acres	Pre-harvest labor and materials	Depreciation		Taxes and insurance	Allowance for general expenses	Total pre-harvest cost and fixed expenses
		Trees	Improvements and equipment			
795	$63 30	$20 00	$4 20	$4 44	$5 41	$97 35

Some of the records for which the location is not certain are not included in this classification.

Table 11 presents the data obtained for the two large holdings of deciduous orchards previously mentioned. These records are for "trees"; that is, for miscellaneous varieties. As in the case of the records in Table 10 nothing is included for irrigation water or for interest. Depreciation on improvements and equipment is taken care of in the labor account. Depreciation of trees at $20 an acre is added to the record supplied by the growers.

TABLE 11

COST OF PRODUCTION PER ACRE FOR DECIDUOUS FRUITS ON TWO LARGE SAN JOAQUIN VALLEY TRACTS, 1929, NOT INCLUDING IRRIGATION WATER OR INTEREST

No.	Area in acres	Pre-harvest labor and material, including depreciation on improvements and equipment	Depreciation of trees	Total
1	574	$55 57	$20 00	$75 57
2	184	61 90	20 00	81 90

Six varieties of deciduous fruits are included in the budget data furnished by the bank previously referred to. Table 12 gives the itemized estimates for each crop, these being intended to amply cover

TABLE 12

BUDGET ESTIMATES OF A SAN JOAQUIN VALLEY BANK COVERING COST OF PRODUCING CERTAIN DECIDUOUS FRUITS[1]

Variety	Plowing and cultivating	Propping	Pruning, brush disposal	Thinning	Spraying	Irrigation labor	Depreciation on trees	Total without depreciation, general expenses and taxes	Total with allowance for depreciation, general expenses and taxes
Nectarines	$11 00	$5 00	$12 00	$6 00	$10 00	$5 00	$20 00	$49 00	$82 00
Apricots	11 00	2 00	12 00	----------	8 00	5 00	20 00	38 00	71 00
Almonds	11 00	----------	5 00	----------	10 00	5 00	20 00	31 00	64 00
Plums	11 00	----------	10 00	----------	10 00	5 00	20 00	26 00	59 00
Figs	11 00	----------	8 00	----------	4 00	5 00	20 00	28 00	61 00

[1] Irrigation water and interest are not included.

actual operations, without either depreciation or interest. The same item for depreciation of trees used in the preceding table has been added.

The Farm Management Section of the College of Agriculture has recently revised its estimate of the cost of producing peaches, this assuming good farm organization and efficient management. Their figures in detail are presented in Table 13. These figures are for pre-harvest operations and material, and are assumed to be the same regardless of yield or variety.

TABLE 13

COST PER ACRE OF PRODUCING PEACHES, AS ESTIMATED BY THE FARM MANAGEMENT SECTION, COLLEGE OF AGRICULTURE, INCLUDING INTEREST AND DEPRECIATION ON IMPLEMENTS AND WORK STOCK

Upkeep on ditches		$2 40
Cover crop:		
Disking, (two ways)	$1 82	
Seed	2 10	
Seeding	0 48	4 40
Pruning		15 77
Brush disposal		1 50
Spraying		25 53
Thinning		32 40
Propping		2 88
Digging borers and so forth		3 60
Disking in cover crop		1 82
Cultivation		3 63
Irrigation labor, including land preparation		4 25
Total		$105 18

In Table 13 there is included an allowance for interest and depreciation on implements and work stock, but no allowance for depreciation on trees. Upon request, the Farm Management Section has revised this table to eliminate interest, and the figure has been added for depreciation on trees, as is given in Tables 10, 11, and 12. These revisions are given in Table 14.

TABLE 14

COST PER ACRE OF PRODUCING PEACHES, AS ESTIMATED BY THE FARM MANAGEMENT SECTION, COLLEGE OF AGRICULTURE, NOT INCLUDING INTEREST ON IMPLEMENTS AND WORK STOCK, BUT INCLUDING THE SAME ALLOWANCE FOR DEPRECIATION ON PEACH TREES AS IS USED ELSEWHERE IN THIS REPORT

Upkeep on ditches		$2 12
Cover crop:		
Disking	$1 66	
Seed	2 10	
Seeding	0 43	4 19
Pruning		15 77
Brush disposal		1 46
Spraying		23 08
Thinning		32 40
Propping		2 88
Digging borers and so forth		3 60
Disking in cover crop		1 66
Cultivation		3 63
Irrigation labor, including land preparation		4 25
Depreciation on trees		20 00
Total		$119 53

It will be noted that the totals presented in Tables 11 and 12 are substantially less than the average of the Agricultural Extension Service. They seem to warrant assuming a lower cost of production than the average of the Extension Service records. However, the costs presented in Table 11 are for highly organized and relatively large

enterprises, and the efficiency of operation reflected in the costs can not be duplicated on the usual individual holdings. The bank budget figures presented in Table 12 likewise must be given less weight for the purposes of this inquiry than those of the Extension Service, because the holdings for which they have been made are in process of financial readjustment, during which time some items are usually neglected, and because the centralized administration of the property should result in savings which individual farmers can not accomplish. The figures given in Table 13 and revised in Table 14 are substantially higher than those shown by the 84 Agricultural Extension Service records, but it should be remembered that the Farm Management Section figures are intended to represent certain definite conditions which can not be expected to be reflected in averages of a large number of individual records.

After considering the general conditions and hazards in the deciduous fruit industry and the consequent need for conservatism, it is believed the averages shown in Tables 11 and 12 should not be used as a basis for conclusions, but that the average shown by the 84 Agricultural Extension Service records should even be increased. The basis for this increase is the higher costs presented by the Farm Management Section and the need for adding to the amount allowed for spraying. The average amount spent for spraying in the Tulare area is between $5 and $6 an acre. It is the recommendation of specialists that this figure should not be less than $14. For purposes of this report the average of the Tulare County records has been raised to the round figure of $105 an acre for total pre-harvest costs and fixed charges.

Starting in, then, with a total pre-harvest cost, together with fixed charges, amounting to $105 an acre, Table 15 has been prepared to show the cost with harvesting included. The table covers a range of yield of from five to twelve tons per acre. Harvesting costs are added at rates varying from $5.50 a ton for yields of five tons to $4.50 a ton for yields of twelve tons.

TABLE 15

AVERAGE COST PER ACRE OF PRODUCING AND HARVESTING PEACHES IN TULARE COUNTY

Cost of production taken at $105 an acre; harvesting figured at from $5.50 a ton for yields of five tons to $4.50 a ton for yields of twelve tons per acre.

Yield in tons per acre	Average cost per acre	Yield in tons per acre	Average cost per acre
5	$132 50	9	$149 57
6	138 14	10	152 86
7	141 50	11	156 07
8	145 57	12	159 00

Income from Peaches and Amount Available for Irrigation Water Charges.

Table 16 shows the income per acre with a yield of five to twelve tons per acre and a selling price of $20 to $50 a ton f. o. b. at the local delivery point.

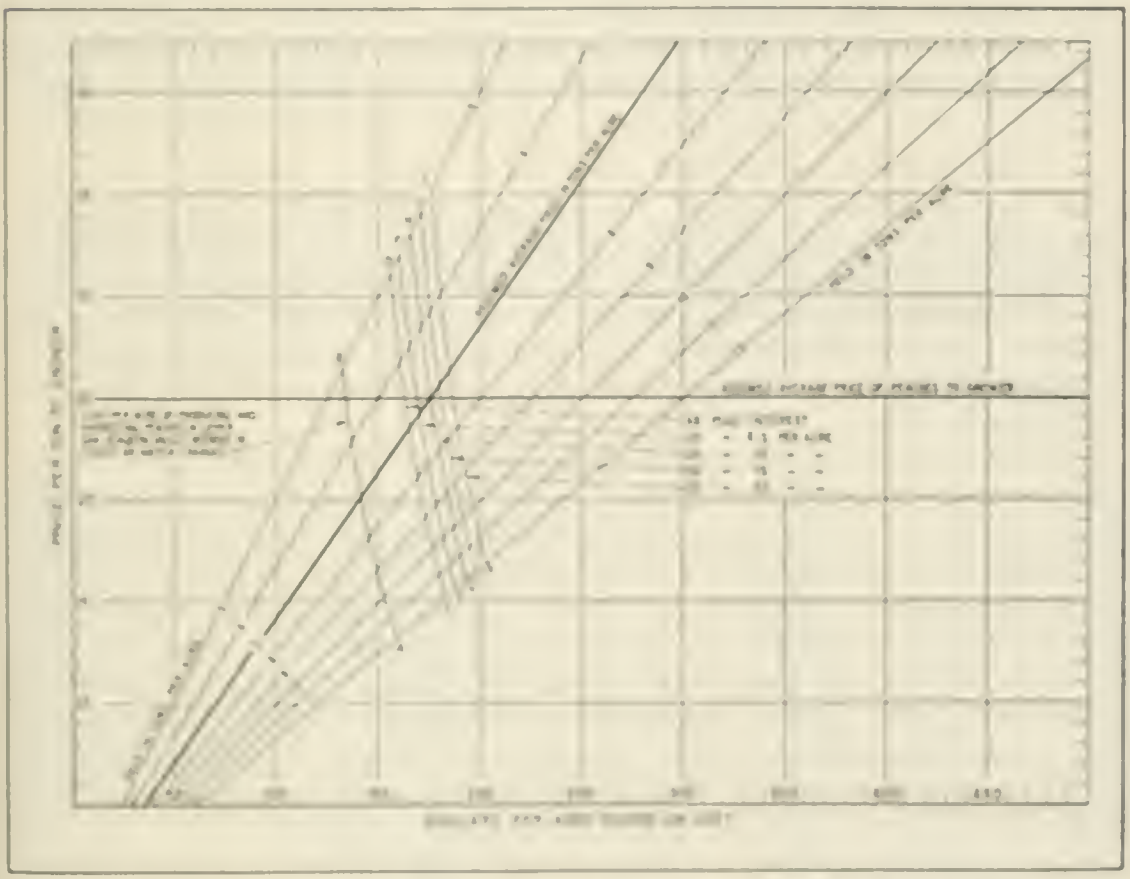
TABLE 16

GROSS INCOME PER ACRE TO GROWERS FROM PEACHES WITH YIELDS OF FIVE TO TWELVE TONS AN ACRE AND A PRICE RANGE OF $20 TO $50 A TON

Yields in tons per acre	$20	$25	$30	$35	$40	$45	$50
5	$100	$125	$150	$175	$200	$225	$250
6	120	150	180	210	240	270	300
7	140	175	210	245	280	315	350
8	160	200	240	280	320	360	400
9	180	225	270	315	360	405	450
10	200	250	300	350	400	450	500
11	220	275	330	385	440	495	550
12	240	300	360	420	480	540	600

Plate II has been prepared to facilitate determination of the yields at a given price or the price at a given yield necessary to return the cost of production and harvesting and also interest at 6 per cent on the average investment.* The curve *AB* in this plate indicates the cost of production and harvesting, and the curve *CD* the cost of production and harvesting, together with interest at 6 per cent. Curves *EF*, *GH*, *KL*, and *MN* represent the additional amounts, by $5 increments, that might, under different assumptions, be required to cover the cost of irrigation water.

PLATE II



RELATION BETWEEN COST OF PRODUCING AND HARVESTING PEACHES AND FARM INCOME

* Average investment of $370 an acre includes land at $200, trees, $110; farm equipment, $30; improvements, $25.

It now becomes necessary to determine the amount of the farm income, above cost of production and harvesting, out of which costs for irrigation water are to be taken. To do this it is necessary to assume a yield and a price for peaches which can be taken as a safe estimate for the future.

The average yield of peaches during the past four years for the 84 records obtained through the Agricultural Extension Service for Tulare County was 7.72 tons an acre. According to Agricultural Extension Service Circular 1, the average* price received by the growers for clingstones during the period 1901–1925 was $39 a ton, and for freestones during the same period, $30 a ton. The same publication gives the average for the period 1921–1925 as the same. In the case of clingstones the range was from $12 to $100, with the price below the average in 15 years out of the 25. In the case of freestones, the range was from $10 to $64, with the price again below the average in 15 out of 25 years.

On the assumption that growers may, on the average, obtain a yield of 7 tons an acre and that on the average they will receive a price of $30 a ton, Plate II indicates that the return an acre to the growers would be $210. This is $68.50 an acre in excess of the cost of producing seven tons an acre. If this yield and this price were to be obtained as an average over a period of years, growers could pay as high as $20 an acre for irrigation water and still show a profit of $24.80 an acre over all costs, including depreciation, interest, and water. With a price of $25 a ton,† which seems a maximum figure to assume, the margin above cost of production and harvesting, together with interest on the average investment, would be reduced to $9.80 an acre. The situation is presented graphically in Plate II.

In addition to the cost data relating to peaches obtained from the Farm Management Section of the College of Agriculture, and already given in Tables 13 and 14, similar information has been obtained from that section relating to apricots. Their total pre-harvest cost per acre, including interest and depreciation on equipment and work stock, an irrigation water charge of $5.62, county taxes, and depreciation on trees, is $166.25 for a six-ton yield of canning fruit, and $149.35 for a four-ton yield.

Because interest on the entire investment, as well as the cost of irrigation water, is included in the cost data reported in Agricultural Extension Circular 24, the data available from that source for deciduous fruits are not entirely comparable with figures supplied by the Farm Management Section, and they are, of course, not comparable with the costs for peaches as presented in the discussion of that crop. However, the figures show relative costs and they therefore are included in Table 17. By way of reconciling the higher costs for peaches in Sutter and Stanislaus counties it might be stated that the yields in the latter counties for the records given are appreciably higher than the average of 7.72 tons for the Tulare County records.

* Unweighted average.

† This figure has been arbitrarily chosen as the highest it seems reasonable to assume, in view of the uncertainties of the peach industry. There is a general feeling that the historical average for this crop, due partly to wide fluctuations, is not a safe guide for the future. If it could be assumed that the price will be fixed by the cost of production where peaches can be grown most cheaply, even $25 would probably be too high.

TABLE 17

DATA REGARDING COST OF PRODUCTION PER ACRE FOR APRICOTS, PRUNES AND PEACHES, AS REPORTED IN AGRICULTURAL EXTENSION SERVICE CIRCULAR 24

Figures include charge for irrigation water and interest on farm investment. Records for 1928 only are given.

Fruit	County	Number of records	Acres in study	Average total cost of production per acre
Apricots	Madera	4	32	$119 79
Apricots	Riverside	8	57	180 81
Apricots	Stanislaus	14	79	170 21
Prunes	Contra	16	389	175 97
Prunes	Napa	21	291	143 28
Prunes	San Bernardino	15	394	144 61
Prunes	Sonoma	17	211	188 62
Prunes	Solano	24	185	158 88
Peaches	Stanislaus	58	240	243 50
Peaches	Sutter	24	287	274 41
Peaches	Tehama	5	44	196 07
Peaches	Tulare	28	250	160 34

The data in the above table, except for peaches in Stanislaus and Sutter counties,* show that production costs for the three deciduous fruits included are of the same general order. Table 18, which gives the net profits from the same fruits over a period of years, shows a much wider variation and makes a satisfactory comparison of the various deciduous fruits impossible. However, Table 18 does give some evidence in support of an assumption, quite generally accepted, that the data presented in the discussion of peaches can fairly be taken to be applicable to other deciduous fruits.

TABLE 18

AVERAGE NET PROFIT OR LOSS PER ACRE FROM PRODUCTION OF CERTAIN DECIDUOUS FRUITS AS REPORTED IN AGRICULTURAL EXTENSION SERVICE CIRCULAR 24, COLLEGE OF AGRICULTURE, UNIVERSITY OF CALIFORNIA

Fruit	Year	County	Number of records	Acres in study	Average net profit or loss per acre
Apricots	1927	Alameda	5	115	$4 67
Apricots	1928	Madera	4	32	−18 [illegible]
Apricots	1928	Riverside	8	57	80 [illegible]
Apricots	1927	Riverside	7	23	−53 14
Apricots	1928	Riverside	8	57	57 [illegible]
Apricots	1927	Stanislaus	11	69	94 41
Apricots	1928	Stanislaus	14	79	−28 [illegible]
Prunes	1928	Napa	21	291	143 28
Prunes	1928	San Bernardino	15	394	144 61
Prunes	1927	Stanislaus	42	111	−5 87
Prunes	1928	Stanislaus	29	111	18 [illegible]
Prunes	1928	Solano	24	185	158 88
Peaches	1927	Solano	30	297	−41 [illegible]
Peaches	1927	Tehama	5	44	42 [illegible]
Peaches	1928	Tehama	13	117	84 17
Peaches	1927	Tulare	19	135	−19 [illegible]
Peaches	1928	Tulare	28	250	−23 [illegible]
Prunes	1928	Contra	15	389	78 [illegible]
Prunes	1928	San Bernardino	15	394	144 [illegible]
Prunes	1928	Sonoma	17	211	188 [illegible]
Prunes	1928	Solano	24	185	158 [illegible]

* No attempt has been made to reconcile the figures for Stanislaus County. They were made up on a somewhat different basis than followed in Tulare County.

Costs of Irrigation Water in the Upper San Joaquin Deciduous Fruit Areas.

Deciduous fruits are not localized as are citrus fruits, but are scattered throughout the developed portions of the areas south of Kings River, except in the Tulare Lake bottom grain sections. However, they are most largely found under the main southside Kings River irrigation systems—Alta Irrigation District, Peoples Ditch Company, and Lucerne and Lemoore Irrigation Districts—and in the vicinity of Tulare Irrigation District, in the Delano-McFarland section, and in the Kern River areas southeast of Bakersfield. Present irrigation costs in these sections are given in Tables 42, 44, 48, 53, 55, and 56.

Costs per acre under the Kern River ditches (Table 42) are low, ranging from 63 to 99 cents, to cite figures for East Side and Kern River canals only, not including additional costs of operating private pumping plants. Under the Kings County water companies (Table 48) the approximate average costs range from 93 cents to $2.45. Under the Kaweah River Delta canals cited (Table 53) the range is $1.01 to $3.28, with some supplemental private pumping not included. For areas supplied exclusively by private pumping plants (Tables 44 and 55) the range in the six cases cited, which are those that include deciduous fruits as among the crops irrigated, is $10.40 to $17.60 per acre.

CHAPTER V

GRAPES

Costs of Production.

The grape industry is such a large and vital part of the agriculture of San Joaquin Valley that its status greatly affects economic conditions in that area. The 1929 crop survey by the State Engineer's office showed Fresno County with 209,110 acres of vines; Tulare, 75,477; Kern, 23,601, and Kings, 16,262. These acreages in the four upper counties of the valley make up 69 per cent of the grape acreage of the entire San Joaquin section, and about 34 per cent of the vineyard area of the United States.*

From a use standpoint, grapes can be classed into three major groups, viz: table, juice and raisin. Since some varieties can be sold under more than one class, as, for instance, Muscats, which may be sold under all three, the price level for such varieties tends to equalize for the various classes. At present the Emperor, a table variety, seems to be receiving a higher price than other grapes, regardless of class, but since it comprises only about 5 per cent of the acreage it does not warrant separate consideration. Parts of Kern County have a good market in the Los Angeles area for early varieties of table grapes, and, as in the case of other special advantages, the vineyards which can reach that early market could pay a higher price for irrigation water. However, the volume of the shipments involved is not sufficient to justify a special classification in this report.

Cost-of-production records to the number of 360 were available from the enterprise efficiency studies of the Agricultural Extension Service. They included 251 in Fresno County, 89 in Tulare County, and 20 in Kern County. Of these 101 were taken for detailed study. In addition, estimates were obtained from a number of shippers and farm managers and cost records were furnished directly by several farmers who keep cost accounts.

Table 19 summarizes the data obtained from the 101 enterprise efficiency studies of the Agricultural Extension Service chosen for study, vineyards under five years old not being included. It will be noted that the average pre harvest cost, not including irrigation water or an allowance for interest but including fixed charges, was $18.40 an acre. Depreciation on vines is based on an assumed investment at five years of age of $225 an acre, this to be written off over a period of 30 years. Since there has been but little planting of vineyards during the last five years, most of the records are for vines in full bearing.

Tables 20 to 24 summarize the estimates or data relating to cost of production of grapes obtained from sources other than the Agricultural Extension Service. It will be noted that the costs shown are not directly comparable with each other or with the averages given in Table 19 because no depreciation is directly figured and because certain other items, such as interest and allowances for supervision and other

* Shear, S. W., and Gould, H. P., Economic Status of the Grape Industry, California Agr. Exp. Sta. Bul. 429. The acreages obtained from the survey by the State Engineer's office ran somewhat above those accepted by the Federal Farm Board as of August, 1929.

TABLE 19

SUMMARY OF DATA RELATING TO THE PRE-HARVEST COST PER ACRE OF PRODUCING GRAPES, INCLUDING FIXED CHARGES, BUT WITH NO ALLOWANCE FOR IRRIGATION WATER OR INTEREST

Data obtained from 101 enterprise efficiency studies made by the agricultural extension service in Fresno, Tulare and Kern counties, 1926 to 1929.

Total acreage, approximately	Pre-harvest cost for labor and materials	Annual depreciation			Taxes and insurance	Incidental expenses	General expense	Total
		Vines	Improvements	Equipment				
800	$29 26	$7 50	$0 92	$1 65	$4 95	$0 12	$3 00	$48 40

overhead, are not treated on a uniform basis. In one case especially (Table 24) the conditions under which the crop were grown were unrepresentative. In spite of the difference involved, the material is included because it shows something of the variation in the data which must be expected in such a study as that reported herein. The summary of the data in Tables 20 to 24, given in Table 25, facilitates comparison.

TABLE 20

COST PER ACRE OF PRODUCING 20 ACRES OF EMPEROR GRAPES, AS ESTIMATED BY A SUCCESSFUL GROWER AND SHIPPER NEAR PORTERVILLE

Pruning	$8 00
Brush disposal	1 50
Tying	1 75
Twine	50
Sulphur	3 00
Labor in sulphuring (seven applications)	2 50
Plowing	3 00
Cultivating, including irrigation furrowing	5 00
Irrigation labor	8 00
Suckering (three times) and thinning	3 50
Miscellaneous	5 00
Total pre-harvest cost, not including fixed charges, interest or irrigation water	$41 75

TABLE 21

LABOR AND MATERIAL COSTS PER ACRE ON LARGE ACREAGE OF VINEYARD AT DELANO, 1929, NOT INCLUDING IRRIGATION WATER AND WITH NO ALLOWANCE FOR INTEREST OR FIXED CHARGES

Varieties included Thompson, White Malagas, Emperor, Muscat and others.

Pruning	$6 14
Tying	2 76
Thinning and suckering	5 91
Irrigation labor	4 19
Plowing furrows	0 59
Sulphur	0 34
Hoeing	0 36
Tractor work	1 18
Pulling leaves	2 06
Brush disposal	1 87
Miscellaneous	0 10
Total	$25 50

In addition to the above, 120 tons were made into raisins at a cost per ton of $13.70 for picking, turning and hauling.

TABLE 22

COSTS PER ACRE OF PRODUCING GRAPES IN TWO TRACTS IN THE UPPER SAN JOAQUIN VALLEY IN 1929, WITHOUT ALLOWANCE FOR INTEREST, IRRIGATION WATER, EQUIPMENT, OR FIXED CHARGES

Miscellaneous varieties

Item	Tract No. 1, 2,824 acres	Tract No. 2, 1,880 acres
Plowing and cultivating	$9 45	$6 03
Fertilizing	0 53	1 17
Pruning and brush disposal	11 98	12 50
Thinning and suckering	7 70	3 70
Pollenization	0 90	0 57
Spraying	0 15	0 04
Sulphuring	5 25	5 26
Pest and weed control	3 89	9 76
Pipe line repairs	0 58	0 93
Irrigation labor	10 51	8 25
Maintenance, etc.	1 63	6 34
General expenses	4 40	11 16
Miscellaneous	1 68	1 97
Totals	$55 65	$68 04

TABLE 23

BUDGET ESTIMATES OF COST PER ACRE OF PRODUCING AND HARVESTING GRAPES AS USED IN 1930 BY A LARGE FARM OPERATOR IN SAN JOAQUIN VALLEY WITHOUT ALLOWANCE FOR INTEREST, DEPRECIATION ON VINES OR IRRIGATION WATER

Figures are averages for seven varieties.

Plowing	$6 00
Cultivating	5 00
Pruning, tying and brush disposal	10 35
Twine	0 25
Sulphur and sulphuring	5 14
Labor irrigating	5 21
Total	$31 95

TABLE 24

COST PER ACRE OF PRODUCING THOMPSON SEEDLESS AND MALAGA RAISINS, 1922 TO 1929, AS FURNISHED BY A PROMINENT GROWER NEAR EXETER

Includes an estimated allowance for the use of irrigation water of $7 per acre for the Thompsons and $10 per acre for the Malagas, but does not include interest.

Variety	Labor, teams and tractor	Fertilizer	Insurance, assessments	Taxes and compensation	Materials and repairs	Depreciation on vines	Depreciation on other property	Total	Total, less estimated cost of irrigation water
Thompsons	$64 89	$2 77	$23 94	$14 94	$4 17	$7 50	$5 26	$124 29	$117 29
Malagas	73 26	3 77	27 84	16 04	7 51	7 50	8 26	138 98	128 98

Note: This grower specializes in producing a fancy pack, involving better care and higher costs than the average.

TABLE 25

SUMMARY OF PRE-HARVEST COSTS PER ACRE OF PRODUCING GRAPES, WITH DEPRECIATION ON VINES AND OTHER FIXED CHARGES ADDED AT THE RATE OF $15.14 PER ACRE[1] WHERE NOT ALREADY INCLUDED

Table number	Amount	Table number	Amount
20	$56 89	23	$47 09
21	40 64	24, Thompsons	117 28
22, tract 1	70 79	24, Malagas	128 08
22, tract 2	83 18		

[1] The average shown by 101 agricultural extension service records as given in Table 19.

The wide range in pre-harvest costs shown in Table 25 might seem to indicate that it is impossible to arrive at a figure representative of the industry. However, as already pointed out, the figures given in Table 25 and in the tables from which they are taken are not strictly comparable. It is the conclusion that the report can most safely proceed on the basis of the 101 Agricultural Extension Service records, the average of which has been shown to be $48.40 an acre for pre-harvest costs, including fixed charges, but without allowance for interest or irrigation water.* The range for these 101 records was from $30.99 to $82.79 an acre.

It is recognized that there is a certain weather risk in harvesting grapes for which allowance needs to be made, but no data are available for evaluating it. In view of this risk a pre-harvest cost of $50 an acre has been arbitrarily assumed.

Income from Grapes and Amount Available for Irrigation Water Charges.

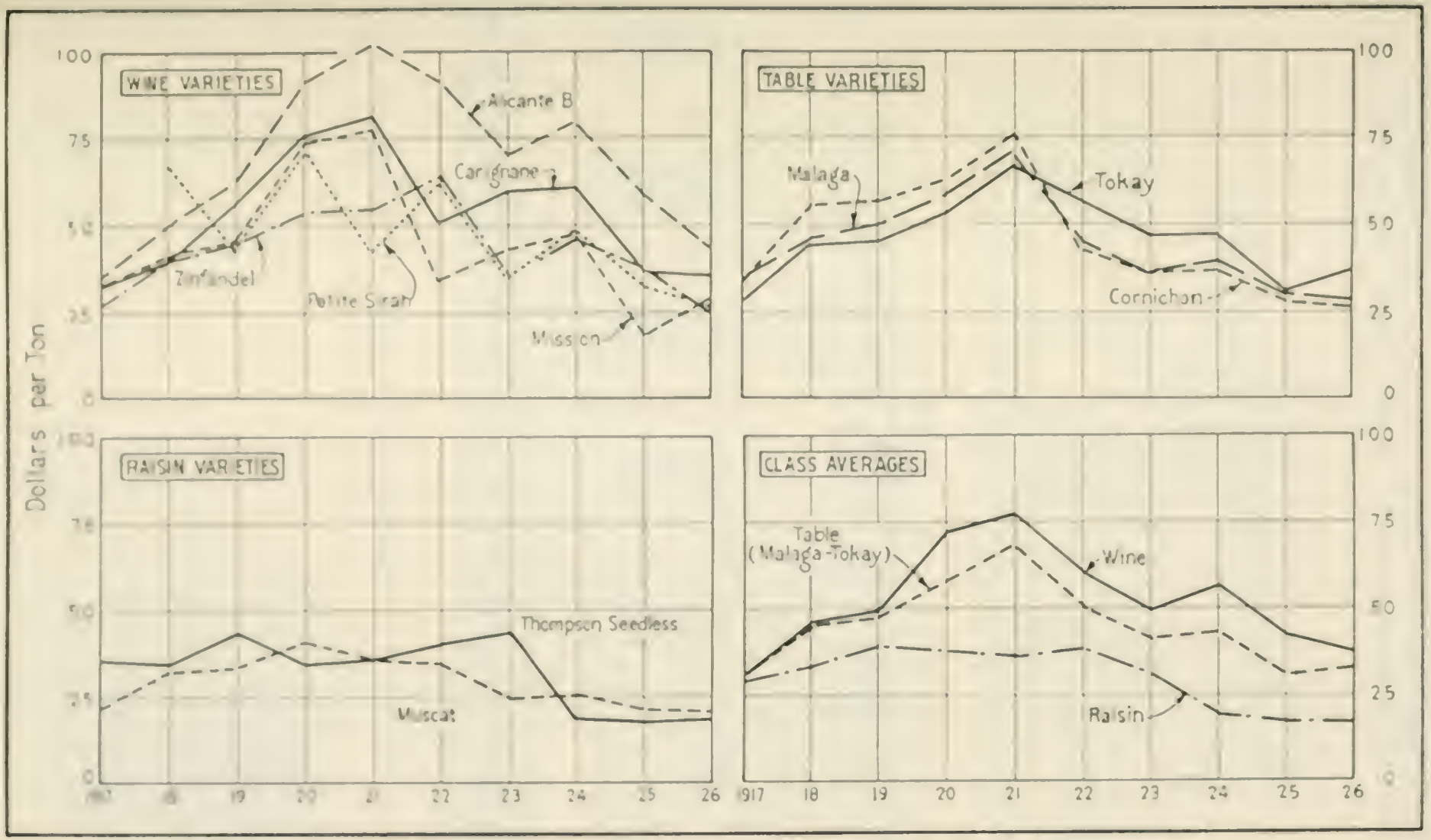
It previously has been stated that grapes are harvested as table grapes, raisins, and juice grapes, some varieties being sold under all three of these classes. It does not seem necessary in the present study to attempt to use more than one class in arriving at permissible irrigation water charges. The class chosen is raisins, since the largest part of the upper San Joaquin grape crop is disposed of in this form.

Basing the study of permissible irrigation water charges for grapes on raisins might be considered by some to be too conservative, since table and juice grapes have generally been bringing higher returns. However, the stabilization plans recently adopted for the entire grape industry in California, and the tendency towards equalization in prices for the varieties sold under all three classes, seem to warrant basing the analysis on raisin grapes only. Plate III, taken from California Agricultural Experiment Station Bulletin 429,† page 92, shows the trend of purchasing power of the various classes over a ten-year period.

After considering the results of his studies extending over several years, it is the judgment of the Farm Advisor of Tulare County that a safe figure to use for harvesting a two-ton crop of raisins would be $15 a ton and for a one-ton crop, $17 a ton, and he has suggested that an average figure of $16 a ton be adopted. On the basis of this figure and the assumed pre-harvest cost of $50 an acre previously referred to,

* The Agricultural Extension Service average was $50.90, which included a depreciation allowance on vines of $10 an acre per annum, whereas the depreciation allowance in this report is $7.50 an acre per annum.

† Shear, S.W., and Gould, H.F., Economic Status of the Grape Industry, California Agr. Exp. Sta. Bul. 429, p. 92.



PURCHASING POWER OF CALIFORNIA FRESH GRAPES BY VARIETIES AND CLASSES, 1917–1926.

PLATE III

Table 26 has been prepared to show the average cost per acre of producing and harvesting raisins in the upper San Joaquin Valley, and Table 27 has been prepared to show the income per acre with yields of .75 to 2.25 tons per acre and a price range of from $40 to $80 a ton.

TABLE 26

AVERAGE COST PER ACRE OF PRODUCING AND HARVESTING RAISINS IN THE UPPER SAN JOAQUIN VALLEY

Pre-harvest cost taken at $50 an acre: Harvesting figured at $16 a ton and no allowance included for interest or for irrigation water.

Yield, in tons per acre	Average cost per acre	Yield, in tons per acre	Average cost per acre
0.75	$62 00	1.75	$78 00
1.00	66 00	2.00	82 00
1.25	70 00	2.25	86 00
1.50	74 00		

TABLE 27

INCOME PER ACRE TO GROWERS FROM RAISINS WITH YIELDS OF 0.75 TO 2.25 TONS PER ACRE AND A PRICE RANGE OF $40 TO $80 PER TON

Yield per acre, tons	Price per ton				
	$40	$50	$60	$70	$80
0.75	$30 00	$37 50	$45 00	$52 50	$60 00
1.00	40 00	50 00	60 00	70 00	80 00
1.25	50 00	62 50	75 00	87 50	100 00
1.50	60 00	75 00	90 00	105 00	120 00
1.75	70 00	87 50	105 00	122 50	140 00
2.00	80 00	100 00	120 00	140 00	160 00
2.25	90 00	112 50	135 00	157 50	180 00

Yields.—Figures regarding average yields of raisins per acre in the upper San Joaquin Valley are not available for long periods or large acreages. Agricultural Extension Service Circular 24 gives the following data:

	1926	1927	1928
Fresno County, Thompson Seedless—			
Number of records	24	20	9
Acres in study	482.3	305.8	203.0
Average yield per acre (dried tons)	1.71	1.75	2.05
Fresno County, Muscats—			
Number of records	9	8	
Acres in study	356.2	218.5	
Average yield per acre (dried tons)	1.47	1.87	
Madera County, Thompson Seedless—			
Number of records		7	17
Acres in study		207.5	324.4
Average yield per acre (dried tons)		1.75	1.71
Tulare County, raisins—			
Number of records		27	25
Acres in study		444.0	357.0
Average yield per acre (dried tons)		1.11	2.00

Yields also are available from 19 enterprise efficiency studies of the Agricultural Extension Service in Tulare County for 1929. The average for this year was 1.81 tons. Nine records for Fresno for 1928 gave an average of 2.05 tons per acre.

Data are not available for making a true average of the above yields. After very careful consideration and consultation with competent authorities, the conclusion has been reached that a yield of 1.50 tons of raisins per acre is a reasonable figure to use for determining farm income in connection with this study.

Prices.—The price of raisins has fluctuated widely. The average for all varieties for the period 1910–1914 was 3.41 cents per pound. From 1909 to 1926 the fluctuation was from 1.68 to 12.61 cents, the latter being for the high-price year of 1920.* According to Agricultural Extension Service Circular 39, presenting the 1930 agricultural outlook for California, the average price paid to growers has not been as high as 4 cents since 1921, and in four of the past eight years the price has been 3 cents a pound or less, with an average in 1929 of 3.5 cents a pound.

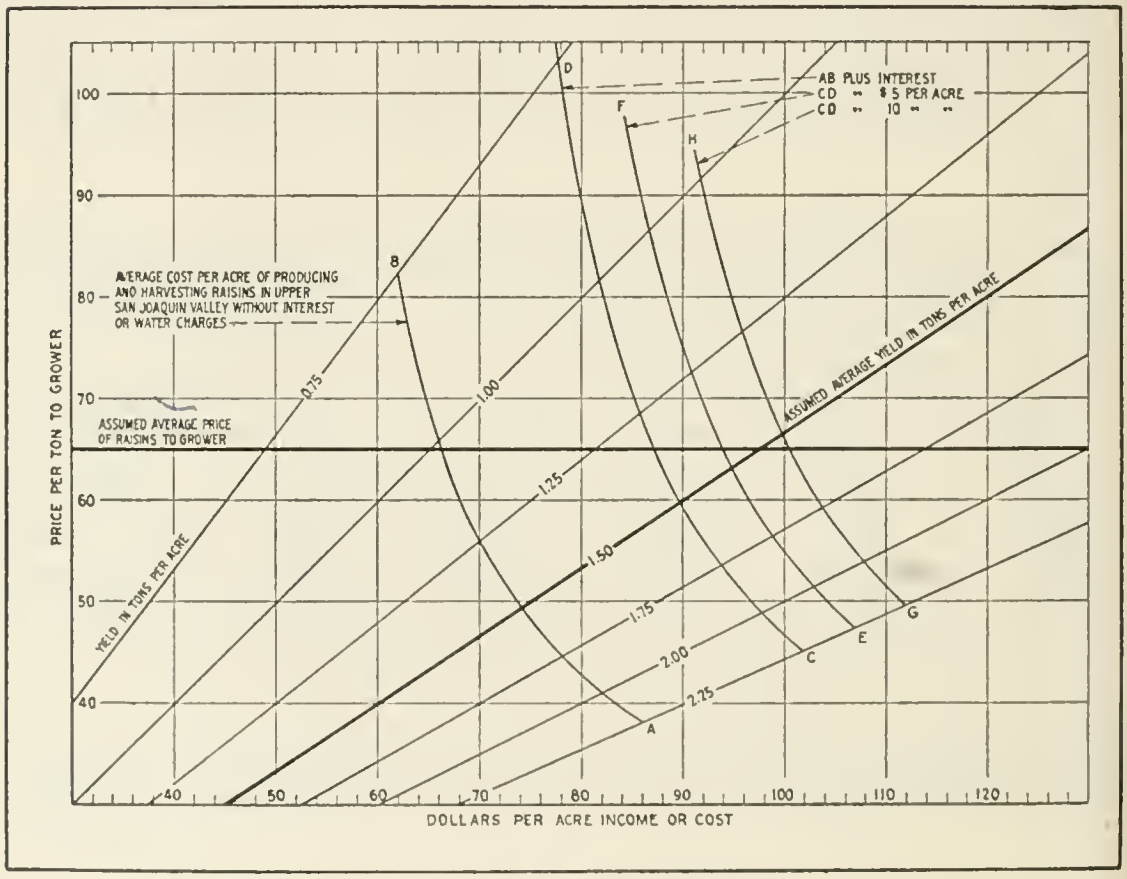
After consultation with those in close contact with the present economic status of the raisin industry in California, a decision was reached that a price of 3.25 cents a pound is the most satisfactory figure to use in connection with this study. Plate IV has therefore been made up on the basis of this price and a yield of 1.50 tons an acre.

This chart, similar to Plates I and II used for Navel oranges and peaches, respectively, presents graphically the situation with reference to costs of production and permissible irrigation water charges for raisins. The heavy lines indicating the assumed average yield of 1.50 tons an acre and the assumed average price of 3.25 cents a pound intersect at a point which indicates returns that will pay the average cost of producing and harvesting the crop, interest at 6 per cent on an average investment of $262.50 an acre,† and leave a margin of $7.75 per acre to cover irrigation water and additional profits.

* Shear, S. W., and Gould, H. P., Economic Status of the Grape Industry, California Agr. Exp. Sta. Bul. 429, p. 185.

† Average investment in vines, $112.50; land, $125; improvements and equipment, $25.

PLATE IV



RELATION BETWEEN COST OF PRODUCING AND HARVESTING RAISINS AND FARM INCOME.

CHAPTER VI

ALFALFA

Costs of Production.

The upper San Joaquin Valley counties are likely always to have a large area in alfalfa, at least as long as irrigation water is available at a "permissible" cost. It is of course primarily a dairy crop, yet it is also grown for market hay and is a basic crop in field crop rotation. For the latter, its use in cotton rotation is one of the best present examples. The 1929 crop survey gave the alfalfa acreage for the entire

TABLE 28

COST PER CUTTING AND PER ACRE OF PRODUCING AND HARVESTING ALFALFA, EXCLUSIVE OF INTEREST AND IRRIGATION WATER, AS ESTIMATED FROM EXPERIENCE AND GENERAL DATA AVAILABLE

Area, 40 acres; yield, six tons per acre

Operation	Per cutting	Per acre per season
Mowing	$0 50	$3 00
Raking	0 25	1 50
Shocking	0 50	3 00
Stacking	1 50	9 00
Baling	3 00	18 00
Irrigation labor	1 00	6 00
General expenses	0 25	1 50
Depreciation on improvements		5 00
Depreciation on equipment		2 00
Taxes		2 00
Total		$51 00
Average cost per ton		$8 50

TABLE 29

COST PER ACRE OF PRODUCING AND HARVESTING ALFALFA ON 186.6 ACRES NEAR CORCORAN, 1929, EXCLUSIVE OF INTEREST AND EXPENSE CONNECTED WITH IRRIGATION WATER SUPPLY

Yield, five cuts and one-third ton per acre

Total pre-harvest cost, per acre		$1 26
Harvest costs—		
Haying	$5 21	
Baling, piling, etc.	18 84	
Insurance and storage	2 78	
Outside teaming	0 74	
		$28 58
Indirect charges—		
Superintendence	$2 44	
Breeding expenses	2 21	
Blacksmithing	0 29	
Administration	0 60	
General county expenses	2 68	
Fuel, gasoline, tractors, etc.	3 44	
Repairs to machinery	1 98	
Repairs to buildings	0 47	
		$13 32
General insurance		0 47
Taxes		1 84
Depreciation		5 03
Total		$49 01
Average cost per ton		$8 73

San Joaquin Valley as 403,270, the acreages in the four upper counties being Fresno, 54,830; Tulare, 54,663; Kern, 30,422; Kings, 21,209.

Cost-of-production data were not available from the Agricultural Extension Service, except for Merced County for 1926–28, and Imperial County for 1928. Some specific data on this crop were, however, obtained during the field study in the upper counties, and the estimates of the Farm Management Section have been made available. Furthermore, alfalfa costs are perhaps more generally known than are the costs for other crops.

Tables 28 to 31 present the data used in arriving at the conclusions given.

TABLE 30

COST PER ACRE OF PRODUCING AND HARVESTING ALFALFA IN IMPERIAL COUNTY, 1928, AND IN MERCED COUNTY, 1926-28, EXCLUSIVE OF INTEREST ON INVESTMENT, BUT INCLUDING INTEREST AND DEPRECIATION ON IMPROVEMENTS AND EQUIPMENT AND COST OF IRRIGATION WATER

Data from Agricultural Extension Service circular 24.

	Imperial County	Merced County		
	1928	1926	1927	1928
Number of records	4	5	15	4
Acres in study	265	133	309	91
Average yield per acre, tons	4.27	5.16	5.44	6.42
Average cost per acre—				
Labor	$28 74	$23 83	$22 72	$24 16
Materials (including water)	6 34	8 10	5 77	11 90
Cost, overhead	5 04	3 85	3 79	3 65
Interest and depreciation (including irrigation equipment)	11 99	8 52	13 04	11 75
Total costs per acre	$52 11	$44 30	$45 32	$51 46
Total costs per acre, less an assumed average water charge of $5 per acre*	$47 11	$39 30	$40 32	$46 46
Average cost per ton, less assumed water charge	$11 03	$7 61	$7 41	$7 24

*There is still left interest on improvements and equipment other than that used for irrigation water.

TABLE 31

COST PER ACRE OF PRODUCING AND HARVESTING ALFALFA IN THE SAN JOAQUIN VALLEY AS ESTIMATED BY THE FARM MANAGEMENT SECTION OF THE COLLEGE OF AGRICULTURE

Does not include interest on land or cost of irrigation water; yield six tons in six cuttings.

Upkeep of irrigation ditches	$2 70
Disking two ways during dormant season	2 20
Mowing	3 78
Raking	1 86
Shocking	2 16
Irrigation labor	3 55
Stacking	6 30
Baling	18 00
Hauling to cars	9 72
Taxes	2 00
Depreciation	2 50
Total	$54 77
Average cost per ton	$9 13

The costs set up in the above tables, although not figured on an entirely comparable basis, do not depart widely from each other, except in one case of low yield. Generally they range from about $7.50 to about $9 a ton, or from $45 to $54 an acre for a six-ton yield, obtained from six cuttings. With a yield of five tons to the acre the cost per ton would be slightly higher.

Present irrigation water costs an acre in the various upper San Joaquin Valley projects under which alfalfa is largely grown, as set out in Chapter VIII, Tables 42, 48, and 53, vary considerably. In the Kern River Delta, they range from 40 cents to $2; in the Hanford area, from 90 cents to $2.45, and under the Kaweah Delta canals, from $1 to $3.25; or, for the various areas, say from 50 cents to $3. In many cases there is an additional cost for operating private pumping plants. Costs cited under pumping plants (Tables 44, 50, 55 and 56, including the plants under which alfalfa is one of the principal crops irrigated) range from $9.60 to $23.60, the higher costs under the pumping plants obviously being unwarranted, except under particularly favorable conditions and good management, and therefore in no sense a guide for project planning.

Income from Alfalfa and Amount Available for Irrigation Water Charges.

Yield.—The California crop report for 1928 gives the average yield for alfalfa in the state for 1926, 1927, and 1928, as 4, 4.20 and 4.20 tons per acre, respectively. This is much below a normal yield on good alfalfa land in the upper San Joaquin Valley. A "good" yield should be at least six tons per acre, but a yield of five tons is considered as high as is justified from which to estimate a permissible water charge.

Price.—Alfalfa prices are not segregated from those of other tame hay in the California crop report. However, prices paid to the grower in the San Joaquin Valley were obtained from the Farm Management Section of the College of Agriculture for the years 1910 to 1928. The unweighted average for this nineteen-year period was $14.15 a ton and the range from $7.17 in 1914, to $23.37 in 1920. For the period 1921 to 1928, which does not include the unsettled war period or the period of generally lower prices before the war, the average was $15.55 and the range from $12.96 to $19.65. An average price of $14 a ton is evidently a safe figure to use for the purposes of this report, in spite of the much lower figure prevailing in 1930.

With a production and harvesting cost for alfalfa of $9 a ton, exclusive of interest and irrigation water—a figure which seems reasonable in the light of the data regarding costs of production given above—and a yield of five tons an acre, the total cost to the grower is $45 an acre. At $14 a ton the gross income would be $70, leaving a margin of $25 an acre to cover interest on the investment, irrigation water, and profits. Assuming a value per acre for land, including improvements and equipment, of $200, $13 an acre would be left for irrigation water and additional profits.

CHAPTER VII

ANNUAL CROPS

Grain.

The crop survey for 1929 made by the State Engineer's office showed 102,000 acres of grain in the three upper San Joaquin Valley counties. This was divided between Tulare County with 10,089 acres, Kings County with 53,310 acres, and Kern County with 38,805 acres. There is some dry-farmed grain, but from the standpoint of the present study the industry is of chief importance in the Tulare Lake area, where all of the grain is irrigated. There is some grain irrigated from pumping on the west side in Fresno County, but otherwise, outside of the Tulare Lake area, grain is irrigated in the upper San Joaquin Valley only where water is available under gravity ditches, or from relatively low pumping lifts, or where the grain is grown incidentally with other crops and is irrigated only to fill in the pumping load and only the cost of power is charged to the grain. So far as grain is concerned, the present inquiry has therefore been confined to the Tulare Lake area. In this report the grain referred to is chiefly wheat and barley.

Grain growing in the Tulare Lake Basin is conducted on large acreages. Cost-of-production data gathered for the report were obtained for approximately 18,000 acres, in holdings varying from 304 to 6,950 acres. In some cases the figures represent the growers' general experience, rather than the costs for a particular year.

The data are not equally complete, but the substance of the material obtained, as far as it can be tabulated, is given in Table 32. General cost-of-production figures that could not be included in the tabulation were obtained from several prominent growers and these were considered in arriving at the conclusions given. No attempt has been made to treat wheat and barley separately.

TABLE 32

COST PER ACRE OF PRODUCING AND HARVESTING GRAIN ON SEVEN TRACTS IN TULARE LAKE BASIN

Number	Area in acres	Total cost of production and harvesting, not including interest or irrigation water	Cost of irrigation water, per acre
3	3,353	$20 17	$8 10
5	1,100	19 53	8 98
6		16 65	
7	1,952	23 39	4 82
8	828	19 10	8 80
9	304	18 31	8 80
10	4,160	17 13	6 30

The total cost of production and harvesting for numbers 5 and 10 included an item of $8.63 an acre for harvest costs estimated at the same rate as number 6, for which there were good cost figures available. The average total cost of production, using all ranches for which figures are included, was $19.18 an acre. Elimination of those for which

estimates of harvest costs were made, gives an average of $19.52. This includes an allowance for depreciation on equipment, taxes, insurance, and, when not otherwise included, for general expenses, estimated at a flat rate of 50 cents an acre. Nothing is included for interest on the investment or for irrigation water. Adding irrigation water at an estimated cost of $7.50 an acre, which is approximately the numerical average of the figures shown in Table 32, and interest at 6 per cent on land at $100 an acre and on farming equipment at $7 an acre, makes a total of $34 an acre to cover all costs. This is on a basis of 20 sacks of wheat an acre, a yield which a number of the growers stated is a fair average. This shows a total cost of producing and harvesting wheat of about $1.26 per hundred with the wheat weighing 135 pounds a sack.

This is lower than figures supplied by several of the large growers and probably indicates, among other things, that the suggested average of 20 sacks an acre is too high. On one large holding in 1929, for which a complete cost record is available, the cost was $1.56 per hundred, and on another, $1.79. In general, growers' estimates range from $1 to $2 per hundred, and one large operator estimated an average of $1.75. Taken together, the data indicate that the usual cost is something less than $1.75 per hundred.

The question now arises as to whether the irrigation water charge of $7.50 an acre referred to in the previous paragraph is justified. That will, of course, depend upon the price received. A prominent grain grower in the Tulare Lake area suggested that a price range of $1.85 to $2.50 per hundred can be assumed. Computations made by the Farm Management Section of the College of Agriculture for the period 1923–1929 show a range of $1.70 to $2.50, f. o. b. shipping point, with the conclusion that $1.90 is a safe figure to use in making computations covering a period of years. On the basis of an average cost of $1.75 per hundred, the margin of profit would be 15 cents per hundred above all costs and interest at 6 per cent on the average investment. On this basis wheat growing in the Tulare Lake basin probably would not be considered attractive to the average grower. In other words, with irrigation water costing $7.50 per acre per year, the industry probably would be left to those who could produce at a lower figure and those who are in a position to speculate on a higher price.

Table 50 on present irrigation costs shows a range in cost of water of $7.90 to $19.60 an acre to irrigators on seven farms using pumping plants to supplement the supply furnished by Corcoran Irrigation District. In the case of three pumping plants under which at least 50 per cent of the area was in grain, the range was from $8.70 to $15.60. In the discussion preceding Table 50 the irrigation water cost per acre on 3353 acres of wheat and barley is given as $8.10 an acre.

These figures indicate that the cost-of-production and yield figures used herein are conservative for present costs. It might be stated further that one large grain grower reported costs of irrigation water varying from $3 to $8 an acre. Another gave a general figure of $4.75. Still another, whose crop was more than two thirds barley, reported an average of $8.70.

It does not seem feasible to reach a final conclusion as to permissible irrigation water costs for grain in the Tulare Lake Basin on any other

basis than present water costs and the general conditions which surround grain growing, because the data available do not permit of a statistical analysis. While the data indicate the present average cost of water in the Tulare Lake grain section approximates $7.50 per acre per year, this is a higher figure than is considered safe to use for state planning for water importation. Hence an abitrary figure of $6 per acre per year is suggested with a full realization that some growers will be able and willing to pay as high as $8 or $10, but also with a realization that to some $6 will be considered a burdensome charge. That is approximately 60 per cent of the average pre-harvest cost of producing the crop, not including interest and the water charge, indicated by the records and estimates used herein. It should be remembered, however, that this applies only to the Tulare Lake area, where large-scale grain farming is the rule.

Cotton.

The cotton industry in the San Joaquin Valley, while of recent origin, has come to be an important one, with a total area in 1929, according to the crop survey by the State Engineer's office, of 256,853 acres. The 1929 plantings in the four upper counties, according to the same source, were Tulare, 69,534 acres; Kern, 64,306 acres; Fresno, 60,512 acres; Kings, 22,033 acres.

Despite the generally pessimistic view of the cotton industry in the San Joaquin Valley, taken perhaps mostly by those not growing this crop, the present size of the industry in the valley requires that it be taken into account in any present planning. The long, warm growing season and the favorable soil conditions in portions of the valley result, under good management, in average yields of about one bale to the acre, with better growers expecting 1.5 bales.

Three sources were drawn on for cost-of-production data. These include 22 records obtained by the Agricultural Extension Service in Kern County from 1926 to 1929, of which three were for renters and not used; five records for 1929 obtained in the field, and five estimates supplied by large ranch managers. The data are summarized in Table 33.

In that table the estimates of ranch managers are appreciably lower than actual costs obtained from the other sources. Without doubt one of the reasons for this is a lower allowance for depreciation. Another is the greater economy in the large-scale operations. In the case of harvest costs, the estimates of the managers are based on contract prices, this presumably accounting for the closeness to uniformity.

Table 34 presents cost-of-production and harvesting data as worked up by the Farm Management Section of the College of Agriculture, the figures including allowances for depreciation on work animals and equipment, but omitting interest and irrigation water.

The figures in Tables 33 and 34 present sufficient variation to warrant differences of opinion as to what should be assumed to be average costs.

In the case of both pre-harvest and harvest costs it will be noticed that, so far as records gathered in the field are concerned, the figures taken from the Agricultural Extension Service enterprise efficiency studies lie between the figures or estimates of ranch managers and those

TABLE 33

SUMMARY OF DATA RELATING TO COST PER ACRE OF PRODUCING AND HARVESTING COTTON IN THE UPPER SAN JOAQUIN VALLEY, EXCLUSIVE OF INTEREST ON THE INVESTMENT AND THE COST OF IRRIGATION WATER, BUT WITH RECORDS OR ESTIMATES OF PRESENT IRRIGATION WATER CHARGES

Source of data	Acres involved	Total preharvest cost per acre, including fixed charges	Harvest cost per bale of lint records	Total preharvest and harvest cost with yield of one bale per acre	Actual or estimated present cost of irrigation water
Agricultural Extension Service records	747	$32 15	$34 21	$67 36	$10 45
Growers—					
No. 1-a	70	37 81	[1] 33 15	70 96	[2] 12 00
No. 1-b	80	34 28	35 70	71 98	[2] 12 00
No. 1-c	120	30 20	37 80	67 00	[2] 12 00
No. 2	500	[3] 30 00	[3] 30 00	60 00	[2] 10 80
No. 3	200	[4] 41 50	[4] 32 50	74 00	
No. 4	150	[5] 32 00	41 74	84 00	8 50
Ranch managers—					
No. 1		[6] 30 70	[6] 30 00	60 70	[6] 6 75
No. 2		[6] 30 00	[6] 32 50	62 50	
No. 3		[6] 19 00	[6] 30 00	49 00	
No. 4		[6] 30 00	[6] 34 25	64 25	[2] 10 00
No. 5		[6] 19 75	[6] 32 50	52 25	[6] 8 50

[1] Range, $20.52 to $46.59 an acre.
[2] Range, $30.37 to $40.59 a bale.
[3] Range, 24 cents to $25.17 an acre.
[4] Budget estimate. Allowances for depreciation in ranch managers' estimates of preharvest cost not comparable with allowances in other records.

TABLE 34

COST PER ACRE OF PRODUCING AND HARVESTING COTTON IN THE KERN AND TULARE AREAS AS SET UP BY FARM MANAGEMENT SECTION, COLLEGE OF AGRICULTURE, INCLUDING DEPRECIATION AND INTEREST ON WORK STOCK AND EQUIPMENT, BUT WITHOUT ALLOWANCE FOR INTEREST ON LAND OR IRRIGATION WATER

Assumed yield per acre: 500 pounds of lint and 1000 pounds of seed

Cutting stalks	$0 54
Plowing	1 50
Harrowing (50 per cent of first plowing)	1 11
Disking	0 41
Harrowing (three times, team)	0 48
Listing	1 29
Planting	0 67
Seed, 25 pounds at 3 cents	1 25
Cultivating growing crop (three times)	1 80
Chopping and thinning	1 80
Hoeing	0 72
Applying water (three times)	2 97
Picking (three at contract rate of "outline")	24 10
Charge for use of picking bags	0 24
Hauling from field	0 80
Hauling to gin	1 00
Ginning	6 25
Bags and ties per bale	0 75
Yardage, insurance and storage	1 25
Taxes	2 00
Total	$56 46
Portion for preharvest costs	$22 23
Portion for harvest costs	34 23

obtained from growers. The preharvest figure of the Farm Management Section is the lowest of all, even below the lowest in the Agricultural Extension Service range, while the harvest costs estimated by the Farm Management Section exceed the numerical average for the others. The Farm Management Section figures, it should be remem-

bered, are based on productive labor necessary in efficient management, and on larger farm units than are the basis of the Agricultural Extension Service costs. They are intended to be applicable only under the particular conditions on which they are based and are in no sense set up as an average.

Because of the belief that the best results in cotton in the future will be obtained by combining it on smaller acreages with alfalfa, and as this probably will result in increasing both costs and yields, a total cost of $65 an acre for producing and harvesting this crop, on a one-bale yield basis, has been arbitrarily assumed. This would involve a slightly higher efficiency than is reflected in the present Agricultural Extension and large-grower records, but a higher cost than that indicated by the figures of the Farm Management Section and the ranch managers' budget estimates. The better growers will have somewhat lower costs, and, as the poorer lands are eliminated, an average of $65 per acre should be a safe figure for use in planning water development.

Income from Cotton and Amount Available for Water Charges.

Yield.—The assumption of an average yield of one bale to the acre in the upper San Joaquin Valley, with the better growers expecting 1.5 bales, has already been referred to. Some growers will not plant land to cotton that will not yield three-quarters of a bale per acre. Others place the lower profitable limit at one bale. The lint yield for eighteen Agricultural Extension Service records available ranged from 0.72 to 2.52 bales to the acre, with a numerical average of 1.35 bales. The unweighted average for the three large-grower records, for which actual costs, rather than estimates, are available, was 1.20 bales to the acre.

As a basis for estimating permissible irrigation water charges it is concluded that a yield of one bale to the acre is justified, knowing that in times of good prices some land producing less than that will be planted.

Price.—Table 35 gives the December 1 farm price of cotton in California from 1910 to 1928. The range is from 7 to 43 cents and the numerical average is 20.5 cents. The October, 1929, to June, 1930, average was 16.25 cents and the June, 1930, price was quoted in the field at 12 cents.

TABLE 35

DECEMBER 1 FARM PRICE FOR COTTON IN CALIFORNIA, 1910-1928

Year	Price in cents per pound	Year	Price in cents per pound
1910	13.3	1920	30.0
1911	7.5	1921	17.0
1912	12.5	1922	26.0
1913	13.0	1923	32.0
1914	7.0	1924	24.0
1915	11.2	1925	22.0
1916	20.0	1926	14.0
1917	28.0	1927	21.0
1918	30.0	1928	19.5
1919	43.0		

Authority, California Crop Report, 1928.

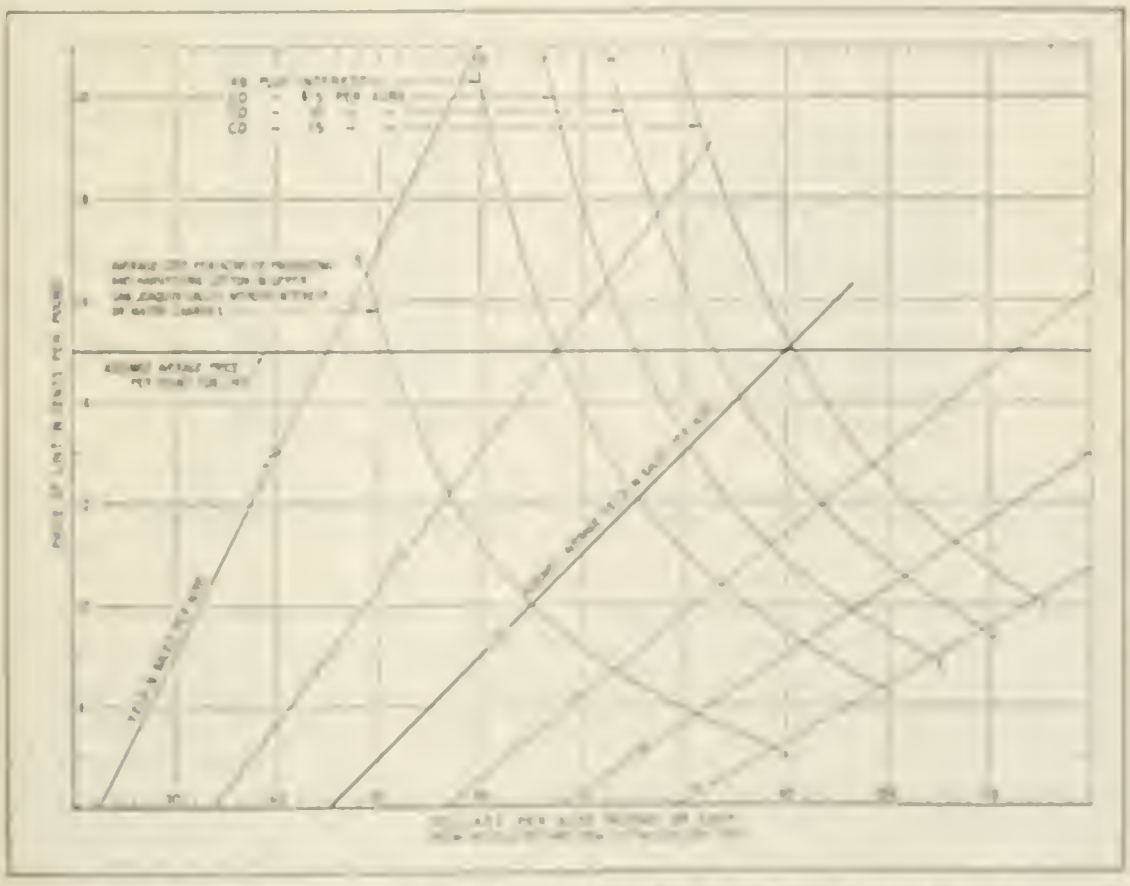
Because of the high war prices included in the table above, the average is not a safe figure to use. The general feeling of qualified observers is that, for irrigation planning, an assumed price to the grower for lint of 15 cents a pound, or $75 a bale, is justified. To this is added, for the purposes of this study, an item of $15 an acre with a one-bale yield for receipts from cotton seed, this being at the rate of 1000 pounds per acre at $30 a ton. The latter is a general average reported by the growers visited. Adding the returns for lint and for seed gives an average income of $90 an acre with a production of one bale to the acre.

Plate V graphically presents the essential data for a conclusion regarding a reasonable charge for irrigation water for cotton in the San Joaquin Valley. The pre-harvest and harvest cost is represented by the curve *AB*. Curve *CD* represents pre-harvest and harvest costs and interest at 6 per cent on a valuation of $175 per acre, including an investment of $40 per acre in improvements and equipment. Curves *EF*, *GH*, and *IJ* represent increases of $5 per acre each.

It will be noted that the line representing the assumed yield of one bale to the acre and the line representing the assumed price of 15 cents a pound intersect at $90 an acre, or $14.50 above the amount necessary to pay pre-harvest and harvest costs with one-bale yield and interest at 6 per cent.

The records or estimates of irrigation water costs for the enterprises considered in the present study (see Table 33) show a range of from

PLATE V



RELATION BETWEEN COST OF PRODUCING AND HARVESTING COTTON AND FARM INCOME

94 cents to $25.17 an acre, with a usual cost of $10 to $12. Costs where cotton is grown, as given in Chapter VIII, are of the same general order, being high under pumping systems in Kern County and the Tulare Lake areas and low under gravity systems.

Miscellaneous Crops.

The term "miscellaneous crops" usually includes such annuals as corn, sorghum, grain, and beans, and, where not grown as specialty crops, would also include vegetables and other truck crops. Ordinarily their water requirements—one or two irrigations per season—are about the same and, when not grown as specialty crops, none of them stands apart from the others as to permissible irrigation charges. A moderate charge for irrigation water for such crops is always assumed. No special inquiry was made in connection with the present study regarding costs of producing these crops, the thought being that present charges for irrigation furnish an adequate guide for them.

Table 36 presents present irrigation water costs under a number of typical San Joaquin Valley irrigation systems which include in their irrigated crops substantial percentages of general crops.

TABLE 36

COST OF WATER AT DELIVERY POINT UNDER SOME TYPICAL SAN JOAQUIN VALLEY IRRIGATION SYSTEMS SERVING SUBSTANTIAL PERCENTAGES OF MISCELLANEOUS CROPS

System	Year	Approximate annual cost of water to irrigators, per acre
Laguna Irrigation District	1927-28	[1]$1 85
Merced Irrigation District	1927-28	[1]9 00
Modesto Irrigation District	1927-28	[1]5 00
South San Joaquin Irrigation District	1927-28	[1]6 45
Turlock Irrigation District	1927-28	[1]4 50
Waterford Irrigation District	1927-28	[1]6 35
Westside Irrigation District	1927-28	[1]9 50
Consolidated Irrigation District	1927-28	[1]2 20
Fresno Irrigation District	1927-28	[1]2 50
Consolidated Peoples Ditch Company	1923-29	[2]1 76
Evans Ditch Company	1923-29	[2]2 94
Farmers Ditch Company	1923-29	[2]1 05
Lateral companies under Last Chance Ditch	1923-29	[2]$1.28 to 1.47
Empire Water Company	1923-29	[2]1 00
Eastside Canal Company	1926-29	[2]0 80

[1] See Bulletin 21, Division of Engineering and Irrigation, State Department of Public Works. In some cases there is an additional cost for operating private pumping plants and for maintenance of secondary laterals.

[2] From Chapter VIII, Tables 42, 48 and 53. In some cases there is an additional cost for operating private pumping plants.

Costs given in the above table are, with three exceptions, seen to be much higher in the irrigation districts than under the mutual and public utility companies represented by the last six listed. The systems which have all-season or nearly all-season water are perhaps best typified by such enterprises as the Modesto and Turlock irrigation districts, both of these having storage and a full gravity supply and both having accomplished the development of most of their irrigable acreages. It is the conclusion of this report that $5 an acre is a reasonable charge for miscellaneous crops in the upper San Joaquin Valley counties.

CHAPTER VIII

COST OF WATER TO IRRIGATORS IN THE UPPER SAN JOAQUIN VALLEY *

Studies of the cost of water to certain irrigators in Kings, Kern and Tulare counties were carried on concurrently with those on the cost of crop production. Excellent cooperation was received from officials of the irrigation districts, water companies, the two power companies and the many individuals called upon for information.

Examination of the tables which follow will disclose that it was possible to obtain the cost to irrigators of gravity water supplied by most of the important gravity systems, but that the number of farms served by individual pumping plants upon which it was possible to obtain reliable data within the time available is a very small part of the total number. Within Kings, Kern, and Tulare counties approximately 11,000 electrically operated pumping plants, not to mention a smaller, but unknown number of engine-driven pumping plants, supply irrigation water, both within and without areas receiving gravity water.

The cost of water to the irrigators receiving water from an irrigation district or water company in any one year or group of years may either be more or less than the cost to the district or company. Since this study is concerned with the cost of water to the irrigators, and not with the cost to the districts or companies, it is not necessary to determine whether charges made by the latter include all items of cost, such as depreciation.

Method of Determining Cost of Water Supplied by Farm Pumping Plants.

The following elements were considered as making up the cost of water to irrigators using farm pumping plants:

1. Power charge for 1929 irrigation season.
2. Repairs and lubrication.
3. Depreciation.
4. Interest.
5. Taxes.

Power charges for 1929 were received directly from the Southern California Edison Company and the San Joaquin Light and Power Company after the plant numbers had been obtained in the field.

Information regarding expenditures for repairs was obtained from individuals, but very few exact records were available. Consequently, it was necessary to use estimates based upon the data at hand and the judgment of the investigator. Usual repair costs per annum varied from $45 for five-horsepower plants to $120 for 50-horsepower plants. Repair costs in the Tulare Lake basin, where the quality of the water

* Prepared by C. V. Given and J. E. Christiansen, junior irrigation engineers, Division of Irrigation Investigations and Practice.

causes excessive corrosion, were from two to three times greater than the usual amounts.

Depreciation was accounted for by setting aside annually an amount, which, when accumulated with interest compounded annually at 4 per cent, would equal the first cost of the wells and pumps at the end of their estimated periods of usefulness. The useful life of a well usually was taken at twenty years. The life of deep wells in the Tulare Lake Basin was estimated at from eight to ten years and some shallow wells from which salty water is pumped were depreciated in five years. The normal life of pumps and accessories was taken at fifteen years, excepting those in Tulare Lake where ten years was used.

It has been suggested that the normal life of deep-well turbines should be taken at twelve instead of fifteen years. Such a change would increase the annual allowance for depreciation on deep-well turbines from 4.99 to 6.66 per cent and would raise the estimated cost of water supplied by farm pumping plants about 5 per cent in most instances.

The following table gives the percentage of first cost which must be set aside annually to accumulate the first cost within the indicated time.

Useful life in years	Percentage of first cost	Useful life in years	Percentage of first cost
5	18.46	15	4.99
8	10.85	20	3.36
10	8.33	25	2.40
12	6.66		

Interest was taken at 6 per cent of first cost and taxes at 1 per cent, excepting in Kern County where an annual charge of 75 cents per horsepower of connected load was made. The assessor of Kern County places a valuation of $25 per horsepower on all irrigation pumping plants, including wells.

Cost of Water to Irrigators in the Foothill Citrus Belt.

The foothill citrus belt of the upper San Joaquin Valley, extending from Kings River to Edison, a few miles east of Bakersfield, is supplied almost entirely with irrigation water pumped from wells. Only small areas are within reach of gravity water. Because of the restricted nature of local ground water supplies, pumping lifts are high, generally ranging from 100 to 250 feet, and the capacity of a pumping plant seldom exceeds 450 gallons per minute, the greater number delivering less than 200 gallons per minute. From 50 to 75 per cent of the pumps used are deep-well plungers.

The information obtained regarding the cost of water to irrigators within this region is summarized in Tables 39, 40, and 41.

Table 39 sets forth water costs within three irrigation districts which delivered water to 14,533 acres in 1929. The usual cost of water to the irrigator was taken as the sum of the assessments and water tolls charged for the 1929 season. In each district the cost of water to certain individuals was determined. It is important to note the wide variation between the usual charge made by the irrigation district

and the total cost of water to individuals, particularly those using private pumping plants to supplement the district supply.

Costs of water to irrigators served by water companies are shown in Table 40. It will be noticed that the costs of water delivered by companies diverting gravity water have been computed by adding assessments and water tolls in 1929 to interest at 6 per cent on the estimated value of the capital stock. The cost to irrigators in the companies delivering water pumped from wells includes the assessments and tolls for 1929 in addition to interest and depreciation on the investment in works.

Table 41 includes the estimated costs of pumping with individual plants for three ownerships. The method used in determining costs has been explained previously. The cost of water from individual plants is subject to much greater variation than indicated by Table 41. In order to indicate the extent to which the cost of pumping varies according to the capacity of the pumping plant, the pumping lift, and the quantity of water pumped, Tables 37 and 38 have been prepared. The costs of pumps and wells were based upon prices prevailing in 1929, and power costs were computed from the P-4-O schedule of the Southern California Edison Company. Depreciation was accounted for by establishing a sinking fund, the annual deposit amounting to 8.33 per cent of the first cost of the pumping equipment and 3.36 per cent of the well cost corresponding to an estimated life of ten and twenty years, respectively. Interest was charged at 6 per cent and an additional 1 per cent was allowed for taxes. Annual repairs were estimated to vary from $45 for the 3-horsepower plunger pump to $75 for the 25-horsepower deep well turbine.

Cost of Water to Irrigators in Kern County Served by Public Utility Water Companies.

A great deal of the area in Kern County now supplied with gravity water, exclusive of the Buena Vista Water Storage District, is served by public utility water companies controlled by the Kern County Canal and Water Company, Bakersfield. These companies are separately incorporated, although they are operated by the controlling company under the direction of a chief engineer and a superintendent. In addition to these public utility companies there are various private canals diverting water, the majority of which are controlled and operated by the Kern County Land Company.

The water supply used by these companies is obtained from the natural flow of Kern River, the diversions being governed in the first place by the Miller-Haggin agreement entered into by owners of lands in the vicinity of Buttonwillow as parties of the first part and the various canal companies and private interests diverting water in the vicinity of Bakersfield as parties of the second part, the agreement being brought about by the decision in the famous *Lux* vs. *Haggin* suit, which definitely established the principles of riparian rights in California. Later on, the Shaw decree established the priorities of most of the diversions of the parties of the second part to the Miller-Haggin agreement, so that finally the diversions are made in accordance with these two documents and also, in the case of the diversions not mentioned in the Shaw decree, according to the dates of the appropriations.

TABLE 37

TOTAL ANNUAL COST OF PUMPING, CAPACITY OF PUMPING PLANT, 200 GALLONS PER MINUTE

Assumed plant efficiency, 50 per cent.

Pumping lift in feet	Quantity pumped in acre-feet	Well		Pump		Pumping costs per acre-foot				Cost per acre	
		Depth in feet	Cost of installation	Horsepower	Cost of installation	Power	Operation, repairs, fixed charges on pump	Fixed charges on well	Total	Duty two acre-feet per acre	Duty three acre-feet per acre
100	75	250	$1,120	10	$1,338	$3 20	$3 50	$1 50	$8 20	$16 40	$24 60
150	75	300	1,560	15	1,718	4 60	4 30	2 10	11 00	22 00	33 00
200	75	400	2,085	20	2,264	6 10	5 50	2 90	14 50	29 00	43 50
250	75	500	2,640	25	2,541	7 60	6 20	3 70	17 50	35 00	52 50
100	150	250	1,120	10	1,338	2 30	1 70	0 80	4 80	9 60	14 40
150	150	300	1,560	15	1,718	3 40	2 10	1 10	6 60	13 20	19 80
200	150	400	2,085	20	2,264	4 50	2 70	1 50	8 70	17 40	26 10
250	150	500	2,640	25	2,541	5 70	3 10	1 80	10 60	21 20	31 80

TABLE 38

TOTAL ANNUAL COST OF PUMPING, CAPACITY OF PUMPING PLANT, 60 GALLONS PER MINUTE

Assumed plant efficiency, 50 per cent.

Pumping lift in feet	Quantity pumped in acre-feet	Well		Pump		Pumping costs per acre-foot				Cost per acre	
		Depth in feet	Cost of installation	Horsepower	Cost of installation	Power	Operation, repairs, fixed charges on pump	Fixed charges on well	Total	Duty two acre-feet per acre	Duty three acre-feet per acre
100	25	200	$890	3	$1,000	$3 20	$7 90	$3 60	$14 70	$29 40	$44 10
150	25	250	1,120	5	1,300	4 70	10 00	4 60	19 30	38 60	57 90
200	25	300	1,560	7.5	1,600	6 90	12 60	6 40	25 90	51 80	77 70
100	50	200	890	3	1,000	2 40	4 00	1 90	8 30	16 60	24 90
150	50	250	1,120	5	1,300	3 50	5 00	2 30	10 80	21 60	32 40
200	50	300	1,560	7.5	1,600	4 90	6 40	3 20	14 50	29 00	43 50

TABLE 19

COST OF WATER TO IRRIGATORS IN IRRIGATION DISTRICTS, FOOTHILL CITRUS BELT, 1929

District	Source of supply	Area and crops irrigated: Total, acres	Area and crops irrigated: Crops	Usual cost of water to irrigators per acre	Principal items making up cost of water per acre to irrigators: [illegible]	[illegible]	Additional pumping cost: [illegible]	Additional pumping cost: [illegible]	Remarks
Terra Bella Irrigation District	Deer Creek; wells	[illegible]	Citrus, 1,8[illegible]; olives, [illegible]; figs [illegible]; vines [illegible]; deciduous, [illegible]	$33	$20 00	$13 00			District water toll [illegible] per acre-foot. Average duty of [illegible] acre-feet per acre for oranges [illegible]. [illegible]
[illegible] individuals in Terra Bella Irrigation District	[illegible] by district	[illegible]	Oranges	39	[illegible]	25 51			
		[illegible]	[illegible]	8	[illegible]	17 72			
		[illegible]	Oranges ([illegible])	49	[illegible]	[illegible]			
		[illegible]	[illegible]	25	[illegible]	[illegible]			
		[illegible]	Oranges	45	[illegible]	29 70			
[illegible] Irrigation District	[illegible] wells	[illegible]	Citrus	[illegible]	[illegible]	[illegible]			[illegible] water toll [illegible] per acre-foot. Average duty of [illegible] acre-feet per acre [illegible] pumping [illegible] irrigators. [illegible] private pumping plants.
[illegible] individuals in [illegible] Irrigation District	[illegible] by district and private pumping plants	[illegible]	Oranges	[illegible]	[illegible]	[illegible]	$10 [illegible]	$17 12	
		[illegible]	Oranges	[illegible]	[illegible]	[illegible]	12 [illegible]	[illegible]	
		[illegible]	Oranges	[illegible]	[illegible]	[illegible]	[illegible]	17 [illegible]	
Lindsay-Strathmore Irrigation District	[illegible] wells	[illegible]	Citrus, [illegible]; [illegible]	11	[illegible]	[illegible]			District water toll [illegible] per acre-foot. Average duty [illegible] acre-feet per acre. About [illegible] private pumping plants supplementing district supply.
[illegible] individuals in Lindsay-Strathmore Irrigation District	[illegible] by district	40	Oranges	40	[illegible]	[illegible]			
		[illegible]	Oranges	[illegible]	[illegible]	11 [illegible]			
		[illegible]	Oranges	[illegible]	[illegible]	[illegible]			
		[illegible]	Oranges	[illegible]	[illegible]	[illegible]			
	Supplied by district and private pumping plants	[illegible]	Oranges	[illegible]	[illegible]	1 [illegible]	7 14	[illegible]	

[1] [illegible]

TABLE 40

COST OF WATER TO IRRIGATORS SERVED BY WATER COMPANIES, FOOTHILL CITRUS BELT, 1929

Name	Source of supply	Area and crops irrigated		Cost of water to irrigators		Principal items making up cost of water to irrigators per acre or per acre-foot				
		Total area in acres	Crops	Per acre	Per acre-foot	Assessment	Water toll	Interest on capital	Interest and depreciation on company investment	Additional pumping costs
First Edison Well Company	Wells	412	Citrus, 306; olives, 68; grapes, 20.	$31		0	$19 70		$10 90	
Second Edison Well Company	Wells	300	Citrus	52		0	37 40		14 40	
Thermal Water Company	White River, wells	160	Oranges, 145; olives, 15	65		0	46 20		18 75	
Pioneer Water Company	Tule River, gravity diversion and wells.		Citrus, deciduous, grapes		*$2 03 [1]22 50	0	2 03 22 50			
Five individuals in Pioneer Water Company.	Served entirely by company	8	Oranges	29		0	27 84	$0 75		
	Served entirely by company	15	Oranges	37		0	36 22	0 60		
	Served entirely by company	10	Oranges, 7.5; lemons, 2.5	55		0	26 93	0 60		$7 50
	Served entirely by company	20	Oranges	30		0	16 20	0 60		13 00
	Served by company and private pumping plant	10	Oranges	38		0	1 44	0 40		36 73
		22	Oranges	36		0	1 80	0 50		33 51
Hilo Water Company	Tule River, wells	80	Oranges	62		$12 25	22 21		$27 95	
Sunnyside Water Company	Tule River, wells	150	Citrus	35		3 60	25 97		5 21	
Pleasant Valley Canal Company	Tule River, gravity diversion	681	Citrus, 294; deciduous, 26; alfalfa, 15; figs, 62; olives, 20; miscellaneous field, 25; pasture, 239.	11		3 60	1 08	6 16		
Antelope Heights Water Company	Kaweah River, boosting from Watchumna Ditch and wells.	400	Oranges, 362; grapefruit, 38	27		0	14 75	12 00		

*Average charge per acre-foot for gravity water delivered.
[1] Average charge per acre-foot for pumped water delivered.

TABLE 41

COST OF WATER TO IRRIGATORS ON THREE FARMS SUPPLIED EXCLUSIVELY BY FARM PUMPING PLANTS, FOOTHILL CITRUS BELT, 1929

Number	Location	Area and crops irrigated		Cost of water to irrigators per acre	Principal items making up cost of water				Number of pumps	Total connected load in horsepower	Approximate lift in feet
		Total area in acres	Crops		Power	Estimated repairs and lubricants	Estimated depreciation	Interest and taxes			
1	2 miles west of Lordsburg	80	Oranges	$31	$10 96	$7 07	$4 53	$6 80	1	10	150-175
2	1 mile east of Orange Cove	20	Oranges	44	9 20	13 10	5 85	6 05	2	6	120
3	2 miles southeast of Orange Cove	250	Oranges	30	9 72	1 80	10 40	8 36	20	91	

The earliest right is that of the Kern Island Canal, with an appropriation of 300 cubic feet per second as of January 1, 1870, while the dates of the original appropriations of the other canals range from 1870 to 1876.

Deliveries are made by the utility companies under rules and regulations established by the Railroad Commission of California in its Decision No. 21973. Under these rules, deliveries are made to definite unit areas in limited rotation periods and the maximum amount delivered per acre during any rotation period is definitely fixed. The canals and laterals to the heads of the consumers' ditches are maintained and operated by the canal companies. The records of deliveries are for the points where the water leaves the companies' canals and do not give the actual deliveries to the land.

A summary of data relating to date of organization, principal crops grown, areas irrigated, average amount of water diverted, amounts of water delivered, charge for water, and average annual costs per acre is given in Table 42. Attention is called to the fact that the average annual costs of water per acre as given are not necessarily the total average annual costs to the area served, as supplemental water is supplied to some of these areas by private pumping plants. This is particularly true of the areas served by the Central, and East Side Canal companies and the Kern River Canal and Irrigation Company. There are no definite data available showing the extent of private pumping for a supplemental supply under any of the canals.

The costs of water to the farmers under these companies bear no definite relationship to the costs of operating the canal systems since the present rates for water for at least the past 30 years have remained the same. A petition is now before the Railroad Commission for an increase in rates.

Under public utility water companies, the right to water service has a value to the lands served. This right to service is somewhat similar to water rights represented by capital stock in mutual water companies. No definite valuation is being placed upon the right to service and no interest is being included on this value in the cost of water figures given. For this reason, annual costs of water under public utility water companies are hardly comparable with annual costs under mutual water companies where interest on the value of capital stock is included.

Cost of Water to Irrigators in Kern County Served Exclusively by Farm Pumping Plants.

Table 44 gives the cost of water to irrigators on seventeen farms in Kern County having a combined irrigated area of 1907 acres which is served by 27 farm pumping plants. Power company records indicate approximately 2000 electric pumping plants were operated within the county in 1929. The first three farms listed in the table are located south of Kern River, above the East Side Canal, while the others are scattered over the main pumping area north of the river, extending from Rosedale to west of Pond near the north boundary of Kern County.

The recent rapid increase in pumping south of Kern River, in the Buena Vista Lake, and near Buttonwillow, is of particular interest. Before the introduction of gravel-envelope wells in these areas, irriga-

TABLE 42

SUMMARY OF DATA RELATING TO CROPS GROWN, AREAS IRRIGATED, AVERAGE AMOUNTS OF WATER DIVERTED AND DELIVERED AND AVERAGE ANNUAL COST OF WATER PER ACRE UNDER EIGHT PUBLIC UTILITY WATER COMPANIES IN KERN COUNTY

Canal company	Buena Vista Canal, Incorporated	Central Canal Company	East Side Canal Company	Farmers Canal Company	Stine Canal Company	Kern Island Canal Company	Kern River Canal and Irrigating Company	Pioneer Canal, Incorporated
Year organized	1878	1890	1887	1880	1878	1870	1892	1871
Principal crops grown (listed according to area)	Alfalfa, cotton, grain	Alfalfa, cotton, grain, deciduous, vines	Cotton, alfalfa, deciduous, vines, field crops, truck	Alfalfa, cotton, grain, deciduous, vines	Alfalfa, cotton, grain, deciduous, vines	Alfalfa, cotton, grain, deciduous, vines	Alfalfa, cotton, grain, deciduous, vines	Alfalfa, cotton, deciduous
Total areas irrigated, in acres—								
1926	7,410	4,004	6,101	4,220	8,017	41,484	3,570	8,500
1927	[illegible]	15,862	6,124	5,470	8,880	40,807	[illegible]	10,346
1928	[illegible]	2,801	6,101	3,888	7,778	41,437	[illegible]	2,748
1929	[illegible]	382	[illegible]	2,800	1,571	40,516	[illegible]	[illegible]
Average	[illegible]	[illegible]	6,120	[illegible]	7,849	41,330	[illegible]	[illegible]
Average amount of water diverted, acre-feet per acre, 1926-1929, inclusive*	2.18	7.76	3.08	3.11		2.82	4.18	2.82
Average amount of water delivered, acre-feet per acre—								
1926	1.96	2.47	2.05	1.32		1.78	2.10	1.02
1927	2.02	5.21	2.60	2.71		1.75	4.06	1.52
1928	1.97	5.07	1.85	1.21		1.87	1.72	1.16
1929	2.97	1.08	1.86	1.70		2.07	1.26	1.52
Average	2.12	3.17	2.19	1.67		1.82	2.43	1.27
Charge for water, per acre-foot delivered†	$0.38	$0.28	$0.38	$0.38		$0.38	$0.30	$0.35
Average cost of water, per acre irrigated‡—								
1926	$0.74	$1.11	$0.78	$0.50		$0.68	$0.63	$0.38
1927	0.77	1.08	0.99	1.04		0.66	1.40	0.58
1928	0.75	1.17	0.70	0.50		0.65	0.52	0.44
1929	0.98	0.00	0.74	0.49		0.79	0.37	0.50
Average	$0.81	$1.20	$0.80	$0.62		$0.69	$0.73	$0.45

* Average of amounts diverted per acre irrigated for each year.

† Charge for water stated in terms of cubic feet per second for 24 hours, at $0.75 per cubic foot per second for 24 hours. One cubic foot per second for 24 hours equals approximately two acre-feet.

‡ Not necessarily the total average annual cost of water per acre for the area, as additional water is supplied by private pumping plants to some of the lands served.

tion pumping was restricted because yields obtained from ordinary stove-pipe wells, which penetrated the fine sands composing the water-bearing material, were not sufficient to make pumping attractive, even though the water table was near the surface. In drilling the gravel-envelope wells, an 18-inch, clean-cut, perforated casing is landed at depths of from 75 to 150 feet. From 25 to as much as 100 tons of gravel is required to form the envelope on the outside of the casing. The prevailing price of drilling is $3 per foot. Casing costs about $5.15 a foot and rock is delivered for $2.35 a ton. The yields of these wells usually range from 1200 to 2000 gallons per minute with pumping lifts of from 30 to 50 feet. The tabulation in Table 43 gives an estimate of the cost of pumping from a gravel-envelope well 125 feet in depth using a 30-horsepower deep well turbine, capacity 1600 gallons per minute, when the pumping lift is 40 feet.

TABLE 43

ESTIMATE OF COST OF PUMPING FROM A GRAVEL ENVELOPE WELL

Deep-well turbine pump; assumed plant efficiency, 55 per cent; pumping lift 40 feet.

Acre feet pumped per annum	Cost of pumping per acre foot		
	Power	Other charges	Total
400	$1 31	$1 15	$2 46
600	1 07	0 77	1 84
900	0 91	0 51	1 42

Annual fixed charges and repairs, included in "other charges" in the above table, are estimated as follows:

Depreciation on well, $1,200 at 5 per cent	$60
Depreciation on pump, $1,600 at 5 per cent	80
Interest on investment, $2,800 at 6 per cent	168
Taxes, 30 horse power, at $0.75 per horse power	22
Annual repairs on well and pump	130
Total annual charges, except power	$460

Cost of Gravity Water in the Hanford Area, Kings County.

The northern part of Kings County, in the vicinity of Hanford and Lemoore, is served by three large canals and several independent laterals. The water supply is obtained from Kings River, these canals being understood to have rights subsequent only to the Fresno Canal in date of priority. The Peoples Ditch, the upper of the three main canals, serves a gross area of approximately 60,000 acres in the northeastern portion of the county, chiefly to the north and east of Hanford. The Last Chance Ditch serves the central portion of about 33,000 acres now embraced in the Lucerne Irrigation District, and the Lemoore Canal serves the Lemoore Irrigation District of about 52,000 acres in the western portion of the area.

The diversions from Kings River are made according to Schedule A of the Kings River Water Association. The schedule allotment for the Lemoore Canal begins with 70 second-feet with the river stage at 200 second-feet. The Peoples Ditch allotment begins with 85 second-feet with the river stage at 300 second-feet and the Last Chance Ditch allotment begins with 46 second-feet with the river stage at 450 second-feet. The schedule allotments increase to a maximum of 450 second-feet for

TABLE 44

ANNUAL COST OF WATER TO IRRIGATORS ON SEVENTEEN FARMS SUPPLIED EXCLUSIVELY BY FARM PUMPING PLANTS, KERN COUNTY, 1929

Number	Location	Area and crops irrigated		Cost of water to irrigators per acre	Principal items making up cost of water				Number of pumps	Total connected load in horsepower	Approximate lift in feet
		Total area in acres	Crops		Power	Estimated repairs and lubricants	Estimated depreciation	Interest and taxes			
1	1 mile north of Arvin	160	Cotton	$24 50	$15 04	$1 30	$3 00	$4 71	1	50	134
2	1.5 miles east of Lamont	141	Grapes, 65; alfalfa, 15; potatoes, 15; figs, 10; peaches, 5	15 40	10 54	0 61	1 76	2 53	2	40	100
3	0.25 mile east of Arvin	75	Grapes, 40; cotton, 25; alfalfa, 10	24 40	10 80	1 47	4 08	7 20	1	40	120
4	4 miles west, 1 mile north of Famoso	153	Alfalfa	11 50	7 58	0 39	1 33	2 13	2	60	40
5	1 mile west of Famoso	20	Alfalfa, 14; milo, 10; cotton 5	11 30	5 76	1 02	1 02	2 34	1	15	50
6	1 mile north of Somerbank	91	Cotton, 61; alfalfa, 30	8 50	4 71	0 64	1 17	1 94	1	20	60
7	0.4 mile north of Shafter	120	Cotton, 60; potatoes, 24; beans, 16; grapes, 14; milo, 10; alfalfa, 8; double-cropped, 18	14 10	9 02	0 87	1 79	2 45	2	35	65
8	1 mile south-west of Shafter	80	Cotton, 18; grapes, 12; potatoes, 11; beans, 7.5; corn 2	12 60	7 50	1 00	1 08	2 28	1	10	75
9	0.5 mile south of Wasco	16	Grapes, 15; cotton, 15	18 10	8 84	1 53	2 11	4 60	1	15	79
10	1 mile north of Wasco	19	Cotton, 14; alfalfa, 5	28 70	12 00	2 63	5 52	8 53	1	15	75
11	1.0 miles west of Wasco	67	Cotton, 42; apricots, 10; peaches, 10; alfalfa, 5	17 60	8 02	1 07	3 20	5 21	1	20	100
12	5 miles South of Wasco	158	Alfalfa, 70; cotton, 45; melons, 20; grain, 20; grapes, 3.5	16 40	9 09	0 79	2 23	3 97	2	40	81
13	1.5 miles north-west of McFarland	75	Cotton, 45; grapes, 20; alfalfa, 10	17 00	8 33	0 81	2 97	4 89	1	25	80
14	2 miles west of McFarland	308	Grapes, 90; truck, 80; beans, 65; milo, 20; nursery, 20; alfalfa, 10; misc. grain, double-crops, 10	13 60	7 16	0 72	2 27	3 21	3	75	105-115
15	0.5 mile east of Pond	87	Cotton	21 80	12 71	1 49	3 05	4 57	1	15	110
16	0.1 mile west of Pond	145	Cotton, 120; alfalfa, 20; corn, 5	16 20	9 52	1 14	2 25	3 29	3	45	75
17	2 miles west of Pond	310	Barley, 118; alfalfa, 92; clover, 80; sudan, 20	9 80	6 53	0 53	1 34	1 41	3	45	60

the Lemoore Canal, 550 second-feet for the Peoples Ditch, and 325 second-feet for the Last Chance Ditch. Table 45 gives a summary of the diversion records for the past seven years.

TABLE 45

SUMMARY OF DIVERSION RECORDS, KINGS COUNTY CANALS[1]

Canal	Peoples	Last Chance	Lemoore
Average date of end of run[2]	August 10	July 19	September 8
Average length of run, days[2]	294	189	303
Annual diversion, acre-feet—			
1923	149,336	63,829	125,360
1924	83,167	18,270	48,419
1925	170,703	63,738	95,059
1926	129,011	52,492	81,671
1927	217,131	97,125	119,498
1928	119,067	45,162	70,305
1929	100,527	36,456	59,643
Average[3]	138,420	53,867	85,708

[1] Kings River Water Master Reports, by Charles L. Kaupke; Division of Water Rights, State Department of Public Works.

[2] Days when the average daily flow was less than five second-feet not counted.

[3] The average annual run-off of Kings River for this period was 1,142,200 acre feet, or 61.8 per cent of the mean annual run-off for the 34 year period, 1896-1929, inclusive. See table 46.

The run-off of Kings River during the period from 1923 to 1929 has been below normal every year except 1927, as shown in Table 46.

TABLE 46

RUN-OFF OF KINGS RIVER AT PIEDRA[1]

Year	Run-off	
	Acre feet	Per cent of mean
Mean (1896-1929, inclusive)	1,763,200	100 0
1923	1,500,300	85 1
1924	399,170	22 6
1925	1,282,300	72 7
1926	1,098,820	63 2
1927	1,983,400	112 5
1928	894,370	50 1
1929	837,190	47 5
Mean (1923-1929, inclusive)	1,142,200	64 8

[1] From records of United States Geological Survey. Records for 1923 to 1929 are from unpublished records, subject to revision, as taken from Kings River Water Master Reports by Charles L. Kaupke.

Because of the average low run-off of Kings River during the last twelve years, the water supply to the lands served in Kings County has not been adequate. Private pumping from wells in the northern part of the area has greatly increased during the past two or three years, but no data are available to show the extent of private pumping or the amount of increase during the past few years on the area. The low run-off of the river and the increase in private pumping have caused a considerable lowering of the water table in some portions of the area and this has entirely changed the irrigation practices in some localities. Formerly, the water table was near the surface of the ground, especially in the northern part of the area which is devoted largely to

the growing of deciduous fruits and vines, often making it unnecessary to irrigate these crops by surface application. A large number of stockholders in the ditch companies sold their stock to water users farther to the south. During the past two or three years surface irrigation of trees and vines has become more necessary and this has undoubtedly been one of the chief reasons for the rapid increase in the amount of private pumping. Although the gravity water is more generally available later in the season in this area than in the Kaweah River Delta, it is often desirable to irrigate some of the crops after gravity water is no longer to be had.

None of the three main canals in Kings County delivers water directly to all of the stockholders. Six independent mutual water companies and one irrigation district distribute water from the Peoples Ditch. Only two of the companies, the Settlers Ditch Company and the Melga Canal Company, own stock in the Peoples Ditch Company. Some of the stock in the Settlers Ditch Company is owned in turn by the Melga Canal Company, the Corcoran Irrigation District, and by users under some of the other ditches. The Melga Canal Company owns stock in both the Peoples and Settlers Ditch companies and also in the Lakeside Ditch Company, which diverts from the St. Johns River, a branch of the Kaweah River. The Corcoran Irrigation District also owns stock in both the Settlers and Peoples ditch companies, but diverts its portion of the water, represented by stock in both companies, directly from the Peoples Ditch. The other four mutual water companies are known as "dry ditches" because they own no water rights nor stock in other companies. They were organized to operate and maintain distributing ditches for stockholders in the Peoples Ditch Company. There is also one incorporated mutual water company operating a sublateral. Holders of about 30 shares of stock in the Peoples Ditch Company obtain water directly from the main ditch or branches of the Peoples Ditch system.

There are seven independent mutual water companies distributing water from the Last Chance Ditch. None of those companies own stock in the Last Chance Water Ditch Company, all of the stock being owned directly by the water users served by those companies. The Last Chance Water Ditch Company delivers water directly to owners of about twelve shares of stock from its main ditch.

The Lemoore Canal and Irrigation Company distributes water to the owners of nearly half of its stock. Some of the stock in this company is owned by the Empire Water Company, a mutual company distributing water to a gross area of 9605 acres in the vicinity of Stratford, and by the Jacob Rancho Water Company, a mutual water company which distributes water to approximately 11,000 acres to the east of the area served by the Empire Water Company. Water also is delivered to one large ranch company which owns about 23 per cent of the stock in the Lemoore Canal and Irrigation Company and maintains its own distribution systems.

It is a general practice for stockholders to rent their surplus stock. During the time when the groundwater table is near enough to the surface to subirrigate, it is often possible for a stockholder to rent all his stock and still produce good crops. In most cases the stock has rented for very little more than the annual assessments. During the

last few years the Corcoran Irrigation District has purchased and rented a number of shares in both the Peoples and Settlers ditch companies. This has resulted in a considerable increase in the value of stock in these companies and has had a marked influence upon the value of stock in the Last Chance and Lemoore ditch companies.

In 1916 the area served by the Empire Water Company on the east side of Kings River was organized as the Stratford Irrigation District for the purpose of taking over the distribution systems, but an agreement was never reached. The district has not been active. In 1920 the area served by the Lemoore Canal was organized as the Lemoore Irrigation District and the Stratford Irrigation District was included within this district, although it did not disorganize. The primary purpose of the organization of the Lemoore Irrigation District was for participation in the proposed Pine Flat project. The gross area of the district is 52,300 acres. The district has never taken over the irrigation system of the canal company.

The area served by the Last Chance Ditch was organized as the Lucerne Irrigation District in 1925 for the purpose of participation in the proposed Pine Flat project. The gross area in the district is 33,407 acres. The district has not taken over Last Chance Ditch.

A summary of data relating to organization, value of stock, annual assessments, and costs of water is given in Tables 47, 48, and 49.

Cost of Water to Irrigators Using Farm Pumping Plants in Tulare Lake Basin.

The principal supply of irrigation water in Tulare Lake Basin is obtained from deep wells, which in this area usually penetrate to depths of 1800 to 2200 feet. Formerly, artesian flow occurred from some of these wells, but continued pumping has caused the water table to recede until pumping lifts range from about 120 to 200 feet.

Deep well turbines are used exclusively for pumping. Thirty to 50-horsepower units usually have capacities of from 500 to 900 gallons per minute, while some larger turbines driven with 100-horsepower motors pump as much as 2000 gallons per minute. Water from the deep wells contains gas and sulphur compounds which corrode both pumps and well casing to such an extent that the usual life is considered to be from eight to ten years. Repair charges are correspondingly high, $1,000 per annum being considered a reasonable amount to cover repairs to a deep well and pumping plant in the lake bottom.

Within recent years water from shallow wells, usually ranging from 50 to 100 feet in depth, has been used to supplement the supply from deep wells in the eastern portion of the basin south of Corcoran. The water from these wells is alkaline and is mixed before being used for irrigation with water from the deep wells. North and east of Corcoran, water from the shallow wells is of better quality. The cost of the shallow wells is usually less than $300, and most of those located south of Corcoran corrode and collapse within five years. Yields of from 150 to 300 gallons per minute are obtained with small deep well turbines driven by 5 and 7.5-horsepower motors.

The high cost of repairs and short life of the wells and pumps is offset to a great extent by the fact that the pumps are operated throughout the year, which reduces the cost of water materially. For instance, the cost of power for irrigating 3353 acres of wheat and barley in the

TABLE 47

SUMMARY OF DATA RELATING TO ORGANIZATION, VALUE OF STOCK, NUMBER OF ACRES PER SHARE AND PRINCIPAL CROPS GROWN UNDER MUTUAL WATER COMPANIES IN THE HANFORD AREA, KINGS COUNTY

Name of company	Address of secretary	Year organized[1]	Shares of stock outstanding	Par value per share	Approximate market value[2]		Approximate usual number of acres per share[3]	Principal crops grown (listed in order of importance)
					Per share	Per acre		
Peoples	Hanford	1871	$62 37	$1 000 00	$10 000 00	$15 60	640	Vines, deciduous, alfalfa
Lemoore Side	Hanford	1892	99 67	12 50			10	Alfalfa, deciduous, vines, pasture
Grant	San Francisco	1913	7,997 54	1 00	13 30	1 60	1	Alfalfa, cotton, grain, corn
Van Dell	Hanford	1895	77 00	100 00			80	Alfalfa, vines, deciduous, grain
Peoples	Hanford	1914	1 128 00	1 00			1	Alfalfa, vines, deciduous, grain
Peoples	Hanford	1874	71 00	100 00			80	Deciduous, alfalfa, vines, grain, cotton
Johnson	Hanford	1888	34 00	1,000 00	5,000 00		320	Alfalfa, deciduous, vines, pasture
Grant	Hanford	888	65 00	40 00			10	Alfalfa, deciduous, vines
Last Chance	Hanford	1873	45 00	1,000 00	5 000 00	7 80	640	Vines, deciduous, grain, alfalfa
Jimmie Side	Hanford						1	Vines, deciduous
Van Side	Hardwick		400 00	10 00			5	Vines, deciduous, alfalfa
Blackmore	Hanford	1921	1 120 00				1	Deciduous, alfalfa
Independent	Hanford	1883	10 82	500 00			320	Alfalfa, grain, deciduous
Last Chance Side	Lemoore	1909	10 00	100 00			160	Alfalfa, grain, deciduous
Van Dell	Lemoore		51 00	100 00			160	Alfalfa, grain, deciduous
Lemoore	Lemoore	1874	54 00	2,000 00	7,500 00	11 70	640	Alfalfa, grain, deciduous, vines
Empire Water[4]	Lemoore							Alfalfa, grain, field crops
Last Chance	Lemoore	1908	11 013 50	5 00			1	Alfalfa, grain, field crops

[1] Year organized refers to the present company, was organized and has no bearing on date of appropriation or date of construction of ditch.

[2] The market value does not give a complete value of the water rights, but depends upon several factors, chiefly outside market and demand for stock, cost of pumping or gravity flow, water rights, crops grown, etc. The figures given are considered conservative and are less than actual prices recently received in some cases.

[3] The number of acres irrigated, per share of stock varies considerably. The figures given represent the acreage for which the stock was originally issued to start water, although in some cases this figure was not available and the approximate average acreage served per share was used.

[4] Mutual capital investment, per share.

[5] Empire Water Company is a commercial water company delivering water for $1 00 an acre.

TABLE 48

SUMMARY OF DATA RELATING TO ASSESSMENT RATES, INTEREST ON CAPITAL STOCK AND APPROXIMATE TOTAL AVERAGE COST OF WATER UNDER MUTUAL WATER COMPANIES IN THE HANFORD AREA, KINGS COUNTY

Name of company	Assessment rates per acre (based on usual number of shares per acre)								Interest at 6 per cent on approximate value of capital stock, per acre	Approximate average cost of water per acre
	1923	1924	1925	1926	1927	1928	1929	Average		
Peoples Ditch[1]	$0 75	$0 60	$0 60	$0 75	$0 90	$0 90	$0 90	$0 77	$0 94	$1 71
Lucerne[2]	1 47	1 14	1 32	1 29	1 62	1 44	1 44	1 39	[3]0 94	2 33
Melga[4]	1 58	1 12	1 24	1 70	1 61	1 74	1 79	1 54	[5]0 80	2 34
New Deal[2]	0 87	0 72	0 72	0 87	1 02	1 09	1 02	0 90	[3]0 94	1 84
Burke[6]	1 12	0 98	1 22	1 12	1 52	1 59	1 27	1 26	[3]0 94	2 20
Riverside[2]	1 37	1 35	1 35	1 50	1 65	1 65	1 67	1 51	[3]0 94	2 45
Settlers[6]	1 00	0 80	0 80	1 00	1 20	1 20	1 20	1 03	0 91	1 97
Union[6]	0 95	0 95	0 85	1 00	1 15	1 15	1 10	1 02	[3]0 94	1 96
Last Chance[7]	0 94	0 78	0 47	0 47	0 78	0 78	0 62	0 69	0 47	1 16
Flowers Side[7]	1 24	1 08	0 77	0 77	1 08	1 08	0 87	0 98	[8]0 47	1 45
First Side[7]	1 14	0 93	0 62	1 07	1 28	0 98	1 02	1 00	[8]0 47	1 47
Hitchcock[7]	1 44	1 03	0 72	0 72	1 28	0 78	1 12	1 02	[8]0 47	1 49
Independent[7]	1 06	0 90	0 60	0 90	0 90	0 90	0 75	0 81	[8]0 47	1 29
Last Chance Side[7]	1 08	0 92	0 60	0 60	0 90	0 90	0 75	0 81	[8]0 47	1 28
York Drop[7]	1 13	0 98	0 72	0 72	1 03	0 97	0 75	0 90	[8]0 47	1 37
Lemoore[9]	0 31	0 62	0 62	0 78	0 62	0 78	0 94	0 67	0 70	1 37
Empire[9]	1 00	1 00	1 00	1 00	1 00	1 00	1 00	1 00	([10])	1 00
Jacob Rancho	0 60	0 60	0 60	0 60	0 60	0 80	0 80	0 66	[11]0 27	0 93

[1] Assessment rates do not include the assessments of any of the independent lateral companies.
[2] Assessment rates include Peoples Ditch Company assessments.
[3] Includes interest only on value of Peoples Ditch Company stock.
[4] Assessment rates per acre given are not actual assessment rates levied, but are based on actual operation costs of the company. Assessment rates levied were lower with the exception of 1925. Balance of operation costs paid from revenues received from sale of stock.
[5] Interest on actual capital investment.
[6] Assessment rates includes Peoples Ditch Company and New Deal Ditch Company assessments.
[7] Assessment rates include Last Chance Water Ditch Company assessments.
[8] Interest only on value of Last Chance Water Ditch Company stock.
[9] Empire Water Company is a contract water company delivering water for $1.00 per acre.
[10] Stock not owned by water users, although the water rights are appurtenant to the land.
[11] Stock is appurtenant to the land. Interest is computed on stock in the Lemoore Canal and Irrigation Company owned by the Jacob Rancho Water Company.

TABLE 49

SUMMARY OF DATA RELATING TO AVERAGE ANNUAL COST OF WATER PER ACRE-FOOT DISTRIBUTED BY MUTUAL WATER COMPANIES IN THE HANFORD AREA, KINGS COUNTY

lake bottom amounted to $16,053, approximately $4.80 per acre and fixed charges, including repairs, brought the total estimated cost up to $8.10 per acre. The pumping lift was about 170 feet.

All farms shown in Table 50 were located within the Corcoran Irrigation District. The assessment on lands within the district for the 1929 season was $2.08 an acre and the water supplied by the district was delivered for $1.50 an acre for one irrigation, the usual application being 6 acre-inches per acre. It will be noticed that four of the farms listed received district water in 1929, and that only one of them used a substantial amount.

Gravity Water Costs Under Mutual Water Companies in the Kaweah River Delta.

The water supply for all of the mutual water companies in the Kaweah River Delta is obtained from the natural flow of the Kaweah River, which is the largest stream in Tulare County. This river has been used for irrigation since 1854. There now are about 20 ditches diverting from the river, most of them being organized and operated as mutual water companies. At McKay Point, a short distance below where the river emerges from the mountains, it divides into two main channels known as the Kaweah River and St. Johns River. Both branches further divide into a number of creeks and sloughs spreading over the delta. The diversions by the companies included in this study are made below McKay Point, from either the main branches or from the creeks.

The diversions are made in accordance with a definite schedule which recognizes the priority of rights. When the stage of the main river above McKay Point falls below 80 cubic-feet per second, the water is all diverted into the Kaweah River branch and is distributed to the following ditches:

Consolidated Peoples Ditch	60 per cent
Evans Ditch	20 per cent
Watson Ditch	20 per cent

When the stage of the river again reaches 80 cubic-feet per second, or after October 1, the flow is divided equally between the Kaweah River and the St. Johns River branches. As the flow of the river increases, other ditches receive water in the following order:

Longs Canal, Flemming Ditch, Oakes Ditch, Persian Ditch, Mathews Ditch, Jennings Ditch, Modoc Ditch, Farmers Ditch, and Uphill Ditch.

Only the ditches with the best rights were included in this study because many of the other ditches receive practically no water during years of low run-off. The water supply for all of the ditches is not sufficient to meet the total requirements of the crops grown. This is particularly true during the late summer and fall when the flow of the river is low. The last twelve years, with the exception of 1922 and 1927, have been years of less than normal run-off. The run-off for 1924 was less than 25 per cent of the mean annual run-off of Kaweah River. The only year of normal run-off for which data are included in this report is 1927.

During the period from 1924 to 1929, inclusive, the Consolidated Peoples Ditch received water from 234 to 365 days each year, or an average of 283 days. The average date of the end of the run was August

TABLE 50

COST OF WATER TO IRRIGATORS ON SEVEN FARMS USING FARM PUMPING PLANTS INSIDE CORCORAN IRRIGATION DISTRICT, TULARE LAKE BASIN

Number	Location	Area and crops irrigated		Cost of water to irrigators per acre	Principal items making up cost of water					Number of pumps	Total connected load in horsepower	Approximate lift in feet
		Total area in acres	Crops		Power	Estimated repairs and lubrication	Estimated depreciation	Interest and taxes	Irrigation district assessments and tolls			
1	7 miles north, 2 miles west, Corcoran	1,000	Alfalfa, 360, barley, 280, wheat, 220, cotton, 80, corn, 30, pasture, 30	[1] $15 60	$5 86	$2 64	$3 55	$2 08	$1 49	1	40	135
										1	30	135
										4	20	40
2	5 miles south, 1 mile west, Corcoran	600	Cotton, 400, wheat, 200	[2] 12 60	4 42	0 71	2 78	2 10	2 59	1	50	140
										3	22 5	50
3	6 miles south, 2 miles west, Corcoran	295	Alfalfa, 135, cotton, 120, barley, 40	[3] 19 20	5 89	2 70	4 21	3 44	3 00	1	40	120
										2	10	33-40
4	2 miles north, 3 miles west, Corcoran	1,600	Barley, 1000, cotton, 427, alfalfa, 80	[4] 8 70	2 17	0 23	0 86	1 49	3 92	3	45	110
										4	27 5	35
5	1 mile north, Corcoran	98	Cotton, 54, oats, 8, alfalfa, 6	[5] 7 90	3 24	0 95	0 73	0 84	2 15	1	10	45
6	0.5 mile south, Corcoran	32	Cotton, 12, alfalfa, 10	[6] 19 60	9 41	2 27	3 27	3 18	2 45	1	5	41
7	0.1 mile east, Corcoran	33	Cotton	[7] 12 70	4 45	1 51	1 67	2 54	2 51	1	7 5	42

[1] 640 acres inside district, 130 acres irrigated once with gravity water.
[2] 150 acres irrigated once with gravity water
[3] 136 acres irrigated once with gravity water
[4] 920 acres irrigated once, 680 acres irrigated twice with gravity water
[5] No gravity water used

26. Because of the seepage loss in the river channel below the points of diversion of the Consolidated Peoples Ditch, the remaining ditches received water for much shorter periods, ranging from 36 to 225 days each year. The average length of run for these ditches was from 99 to 167 days, the average date of the end of the runs occurring between June 21 and July 12.

Practically all of the area served by gravity ditches in the Kaweah River Delta receives supplemental water from private pumping plants. Because of the low run-off of the river during the last decade there has been a large increase in the number of plants and amount of power used. There are no data showing the exact number of pumping plants used to supplement gravity supplies, but records of the Southern California Edison Company, given in Table 51, show the following increases during the last five years within the exterior boundaries of the areas served by the mutual water companies included in this study. These figures do not include the Elk Bayou Area, which receives some water from the Consolidated Peoples Ditch, but depends upon pumping for most of its supply.

TABLE 51

EXTENT OF PRIVATE PUMPING ON AREAS SERVED BY SOME OF THE MUTUAL WATER COMPANIES IN THE KAWEAH RIVER DELTA[1]

Year	Number of plants	Connected load in horsepower	Energy used in kilowatt hours	Estimated[2]	
				Acre-feet pumped[3]	Power cost[4]
1924	193	1,951	2,949,671	33,600	$47,500
1925	235	2,373	2,969,626	32,200	52,900
1926	320	3,449	4,496,508	47,900	77,000
1927	357	3,835	3,624,667	39,200	71,800
1928	397	4,471	7,057,890	72,700	107,300

[1] Records made available through the courtesy of C. H. Holley. These figures are for full sections within the general areas served by the Consolidated Peoples (exclusive of the Elk Bayou Area), Evans, Farmers, Flemming, Jennings, Mathews, Modoc, Oakes, Persian, Uphill and Watson ditches. They are intended to show only the relative amount of pumping and the increase within the same area in a five-year period. The total area included is 64, 640 acres, of which 28,655 acres were actually cropped and irrigated in 1929, according to crop surveys made by the Division of Water Resources, State Department of Public Works.

[2] Estimated from power companies' records.

[3] Based upon available data regarding average depths to the water table, estimating average drawdowns and efficiencies.

[4] Based upon relationship between average size of plant and average amount of power used and power rate in accordance with Southern California Edison Company Agricultural Power Schedules P-4 and P-4 Optional.

Table 51 indicates that there has been an increase of more than 100 per cent in supplemental pumping from 1924 to 1928. Partial records for 1929 indicate a material increase over 1928.

This enormous increase in pumping has resulted in a general lowering of the water table of from 5 to 15 feet between 1924 and 1929 over most of the area in the delta receiving gravity water from the above mentioned ditches and a much greater lowering on areas not receiving gravity water. Before private pumping was very common, the water table stood within 5 to 10 feet from the ground surface in many places. Large areas depended entirely upon subirrigation. In some places trees and vines were irrigated only occasionally by surface application. Alfalfa was sometimes irrigated only once or twice during a season. Since the lowering of the water table below the root zone, these conditions have changed and the annual surface applications have increased. These increased applications are met largely by supple-

mental pumping, which partially accounts for the tremendous increase in pumping during the past six years.

What data are available indicate a relatively low duty of water in the Kaweah River Delta. Most of the soils are sandy loams and fine sandy loams. Diversion records and pumping records indicate a net duty often in excess of four acre-feet per acre on areas mostly in alfalfa, deciduous fruits and vines.

The lowering of the water table also has had a noticeable effect upon seepage from the ditches and natural channels used for the distribution of gravity water. In some of the creeks that formerly acted as drainage channels for the delta, the seepage losses at present are so great that gravity water seldom reaches the users on the lower end. This is particularly true of Outside Creek, one of the natural channels used to distribute water from the Consolidated Peoples Ditch. Although a considerable amount of water was turned in at the head, practically no water was received by the users in the Elk Bayou area, either in 1928 or 1929.

Another important factor in the cost of water is the type of service rendered. With the exception of the Consolidated Peoples Ditch, the companies included in this study deliver water to the head of small private ditches, usually to individual farms. In most cases the water is delivered on a rotation basis, the length of run to each person depending upon number of shares of stock owned. The stock is not appurtenant to the land, and, because of a large number of exchanges of stock between individuals, the ratios between number of shares owned and the area irrigated by different individuals varies widely, and at present, on most of the ditches, it is very difficult to determine the usual number of acres per share. Since supplemental pumping has become general, some of the original stockholders have sold all their stock in the ditch companies and depend entirely upon pumping plants. This was sometimes formerly done where a general high water table existed and no surface applications were made.

The Consolidated Peoples Ditch delivers water only to the head of independent laterals. Some of these laterals are small and practically the entire cost to the irrigator is represented by the assessments and interest on the value of the stock of the Consolidated Peoples Ditch Company. In other cases it also is necessary for the irrigator to own stock and pay additional assessments in both main lateral and sub-lateral ditch companies before he can obtain water. The costs on the lower end of the system are, therefore, generally higher than on the upper end. These differences for some of the more important, or organized, laterals distributing water under the Consolidated Peoples Ditch are shown in Table 53. Lateral ditch companies diverting from Outside Creek were not included because of the uncertainty of their water supply.

An item representing a considerable portion of the cost of water to all of the companies considered is litigation. Since 1916, most of the companies diverting from Kaweah River have been engaged in litigation with the Lindsay-Strathmore Irrigation District.

A summary of data regarding organization, value of capital stock, principal crops grown, assessment rates per acre, interest on capital stock, and approximate average cost of water per acre, is given in Tables 52, 53, and 54.

TABLE 52

SUMMARY OF DATA RELATING TO ORGANIZATION, VALUE OF STOCK, NUMBER OF ACRES PER SHARE AND PRINCIPAL CROPS GROWN UNDER MUTUAL WATER COMPANIES IN THE KAWEAH RIVER DELTA, TULARE COUNTY

Name of company	Address of secretary	Year organized[1]	Shares of stock outstanding	Par value per share	Approximate market value[2]		Approximate usual number of acres per share	Principal crops grown (listed in order of area)
					Per share	Per acre		
Consolidated Peoples	Exeter	1874	9,322 00	$25 00	$35 00	$21 00	1.67	Deciduous, vines, alfalfa, cotton, corn
Locust Grove[3]	Exeter	1891	270.00	5 00			6.67	Vines, deciduous, alfalfa, truck
Extension[3]	Exeter	1874	38.31	100 00			160.00	Deciduous, alfalfa, corn, cotton
Sims-Davis[3]	Visalia		1,069.00				1.67	Deciduous, alfalfa, vines, cotton
Blain[3]	Visalia	1925	6.03				160.00	Deciduous, alfalfa, grain
Lower Extension[3]	Farmersville	1902	612.00	5 00			4.00	Deciduous, alfalfa, grain
Evans	Visalia	1854	992.00	100 00	50 00	20 00	2.50	Vines, deciduous, alfalfa, cotton
Farmers	Tulare	1875	199.25	100 00	400 00	10 00	40.00	Alfalfa, deciduous, cotton, vines
Jennings	Visalia		80.00	100 00	100 00	10 00	10.00	Alfalfa, deciduous, vines
Mathews	Visalia		768.00	10 00	10 00	6 67	1.50	Alfalfa, deciduous, corn, grain
Modoc	Visalia	1891	100.00	100 00	500 00	12 50	40.00	Alfalfa, deciduous, vines, corn
Oakes	Visalia	1901	34.00	50 00	200 00	6 67	30.00	Deciduous, alfalfa, vines, corn
Persian	Visalia		14,673.00	2 00	2 00	8 00	0.25	Alfalfa, deciduous, cotton, corn
Uphill	Visalia	1901	700.00	10 00	25 00	9 25	2.70	Alfalfa, deciduous, vines, corn
Watson	Visalia		585.00	100 00	100 00	20 00	5 00	Alfalfa, deciduous, cotton, corn, vines

[1] Year organized refers only to present company and has no bearing on date of appropriation or date of construction of ditch.

[2] The market value does not give a relative value of the water rights, but depends upon several factors, such as outside market and demand for stock, cost of pumping in given area, water rights, crops grown, etc. The figures given are considered conservative and are less than actual prices recently received in some cases.

[3] Independent lateral ditches distributing water from the Consolidated Peoples Ditch.

TABLE 53

SUMMARY OF DATA RELATING TO ASSESSMENT RATES, INTEREST ON CAPITAL STOCK AND APPROXIMATE TOTAL AVERAGE COST OF WATER UNDER MUTUAL WATER COMPANIES IN THE KAWEAH RIVER DELTA, TULARE COUNTY

Name of company	Assessment rates per acre (based on normal number of shares per acre)								Interest at 6 per cent on approximate value on capital stock per acre	Approximate average cost of water, per acre
	1923	1924	1925	1926	1927	1928	1929	Average		
Consolidated Peoples[1]	$0 78	$0 31	$0 37	$0 60	$0 42	$0 48	$0 51	$0 50	$1 20	$1 70
Lovelace Ditch[2]	1 08	0 91	0 67	1 00	1 02	1 08	1 11	1 10	[illegible]	[illegible]
Extension[2]	0 86	0 82	0 87	0 89	0 81	0 79	0 70	0 78	[illegible]	[illegible]
Elder Ditch[2]	1 09	1 79	1 35	1 09	0 91	1 04	1 03	[illegible]	[illegible]	[illegible]
Daily[2]			1 10	0 89	1 21	0 99	0 49	1 02	[illegible]	[illegible]
Lower Consolidated[2]	1 05	0 75	1 00	0 84	1 06	0 87	0 81	0 91	[illegible]	[illegible]
Evans	2 50	1 20	2 00	2 00	1 00	2 00	1 20	1 74	1 20	2 94
Farmers	0 50	0 50	0 50	0 50	0 50	0 50	0 12	0 45	0 60	1 05
Jennings	1 68	1 85	2 40	4 00	4 00	4 00	2 05	2 85	0 90	3 75
Mathews	1 00	1 17	1 00	1 17	2 00	0 85	0 83	1 13	0 40	1 53
Mosher	1 50	0 25	1 00	1 00	0 50	0 50	0 75	0 64	0 75	1 39
Oaton	2 50	0 25	0 50	0 50	0 67	0 83	0 83	0 61	0 40	1 01
Perkins	0 80	1 00	1 00	0 80	1 20	1 00	0 80	0 94	0 48	1 42
Quick	1 11	0 74	0 74	1 11	1 11	0 74	0 74	0 90	0 55	1 45
Watkins			1 20	1 72	1 17	1 20	1 30	1 32	1 20	2 52

[1] Assessment rates include only those of the Consolidated Peoples Ditch Company. Costs per acre are for stockholders obtaining water through the smaller independent laterals which are operated without additional assessments.

[2] Assessment rates include Consolidated Peoples Ditch Company assessments.

[3] Interest on Consolidated Peoples Ditch Company stock only.

[4] Assessment rates include Consolidated Peoples Ditch Company and Extension Ditch Companies' assessments.

TABLE 54

SUMMARY OF DATA RELATING TO AVERAGE ANNUAL COST OF WATER PER ACRE-FOOT DIVERTED BY MUTUAL WATER COMPANIES IN THE KAWEAH RIVER DELTA, TULARE COUNTY

Name of company	Average cost of water diverted, per acre-foot													
	Excluding interest on value of capital stock							Including 6 per cent on value of capital stock						
	1924	1925	1926	1927	1928	1929	Average	1924	1925	1926	1927	1928	1929	Average
Consolidated Peoples[1]	$0 20	$0 08	$0 17	$0 07	$0 17	$0 15	$0 14	$1 01	$0 33	$0 54	$0 30	$0 62	$0 54	$0 48
Evans	1 24	0 76	0 86	0 25	0 79	0 49	0 68	2 49	1 22	1 37	0 56	1 27	0 99	1 20
Farmers[2]	3 85	0 15	0 24	0 10	0 39	0 08	0 20	8 50	0 33	0 54	0 21	0 86	0 48	0 46
Jennings[3]	1 02	0 40	0 91	0 55	1 54	0 50	0 70	1 40	0 50	1 05	0 63	1 80	0 64	0 84
Mathews	0 57	0 23	0 30	0 31	0 32	0 24	0 31	0 78	0 32	0 40	0 38	0 47	0 36	0 41
Modoc	0 24	0 27	0 50	0 12	0 25	0 34	0 26	0 96	0 47	0 88	0 30	0 63	0 69	0 56
Oakes	0 46	0 20	0 28	0 21	0 38	0 45	0 30	1 02	0 36	0 50	0 33	0 57	0 66	0 49
Persian[4]	1 60	0 40	0 45	0 29	0 80	0 68	0 50	2 37	0 60	0 72	0 40	1 19	1 08	0 75
Uphill	0 98	0 20	0 53	0 27	0 35	0 31	0 34	1 71	0 35	0 79	0 41	0 61	0 54	0 56
Watson	----------	0 54	0 92	0 39	0 56	0 66	0 59	----------	1 08	1 57	0 79	1 12	1 26	1 12

[1] Based upon assessments and interest on Consolidated Peoples Ditch Company stock only. Assessments and interest on stock in lateral companies not included.

[2] Average costs per acre-foot, measured at head of Deep Creek about 6.5 miles above head of Farmers Ditch.

[3] Cost per acre-foot for net amount diverted, after deducting 25 per cent delivered to the Persian Ditch.

[4] Cost per acre-foot for amount diverted by Persian Ditch, plus 25 per cent of amount diverted by the Jennings Ditch.

Cost of Water to Irrigators Supplied Exclusively by Farm Pumping Plants, Kaweah Delta, and Tule River-Deer Creek Areas, Excepting Foothill Citrus Belt.

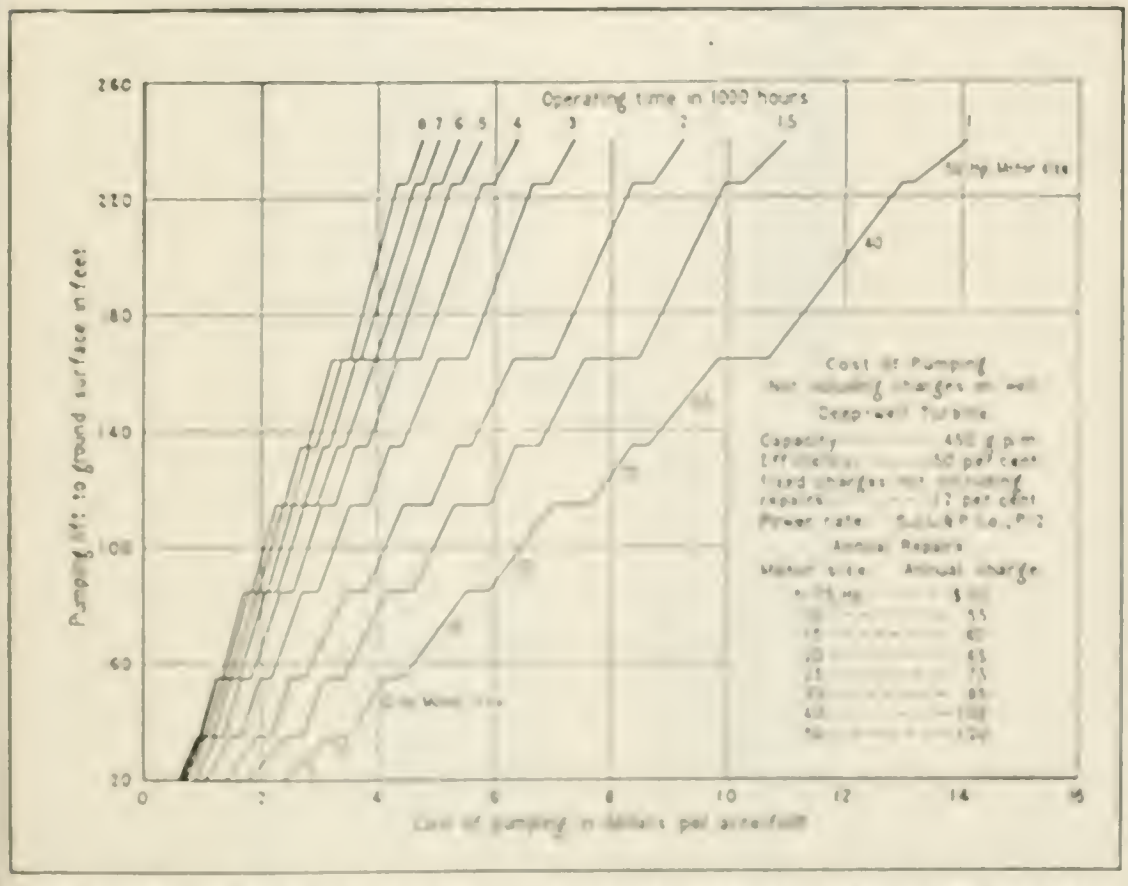
The cost of irrigation water supplied exclusively by farm pumping plants serving ten farms in Kaweah Delta Area and seven in the Tule River-Deer Creek area is shown in Tables 55 and 56. It will be noticed that costs on the seven farms in the Tule River-Deer Creek area vary between $6 and $12.40 an acre, while those in the Kaweah Delta area range from $9.60 to $23.60 an acre.

This difference between the range in costs in the two groups can not be taken as an indication that the usual cost of water supplied by farm pumping plants in the Tule River-Deer Creek area is less than the usual cost in the Kaweah Delta area, because it is obvious the number of pumping plants included in each group is a small part of the total number in operation. However, as examples of the cost of water to certain irrigators, the reported costs fulfill the purpose for which they were obtained.

Cost of Pumping With Deep-well Turbines.

As explained on page 20, data on the cost of water to irrigators using farm pumping plants was obtained for a small number of farms, forty-four to be exact, of the thousands using such plants in Tulare, Kings, and Kern counties. In selecting these samples an attempt was made to include representative farms in each of the above counties. How-

PLATE VI



COST OF PUMPING, NOT INCLUDING CHARGES ON WELL WITH DEEP-WELL TURBINE, CAPACITY 450 GALLONS PER MINUTE.

TABLE 55

ANNUAL COST OF WATER TO IRRIGATORS ON TEN FARMS SUPPLIED EXCLUSIVELY BY FARM PUMPING PLANTS, KAWEAH RIVER AREA, 1929

Number	Location	Area and crops irrigated		Cost of water to irrigators per acre	Principal items making up cost of water				Number of pumps	Total connected load in horsepower	Approximate lift in feet
		Total area in acres	Crops		Power	Estimated repairs and lubricants	Estimated depreciation	Interest and taxes			
1	4 miles north, 5 miles east, Visalia	38	Grapes, 29; figs, 8	$11 10	$6 71	$0 79	$1 82	$1 74	1	10	41
2	2 miles west, 4 miles south, Visalia	45	Alfalfa and sudan	11 10	5 42	1 22	1 78	2 71	1	15	50
3	3 miles west, Exeter	77	Peaches, 30; prunes, 30; grapes, 17	10 40	5 96	0 70	2 04	1 72	1	15	45
4	5 miles east, 2 miles south, Tulare	35	Prunes, alfalfa inter-crop	[1]15 20	9 08	1 57	1 63	2 48	1	15	40
5	1 mile north, Tulare	36	Alfalfa, 27; oats and corn, 9	16 00	11 28	1 39	1 39	1 94	1	10	75
6	2 miles north, 1 mile west, Goshen	190	Alfalfa and grain, 130; grain, 60	11 20	7 98	0 63	1 26	1 37	4	50	35-40
7	7 miles west, Tulare	110	Alfalfa	14 10	9 36	0 75	1 48	2 54	1	30	78
8	8 miles west, 4 miles south, Tulare	154	Cotton, 106; alfalfa, 48	15 00	9 95	0 93	1 47	2 69	3	55	80-90
9	0.5 mile south, Waukena	18	Alfalfa	23 60	12 00	2 78	3 67	5 17	1	10	55
10	8 miles west, 4 miles north, Tulare	408	Cotton, 228; alfalfa, 80; barley, 80; grapes, 20	9 60	6 20	0 67	1 03	1 67	5	85	50-65

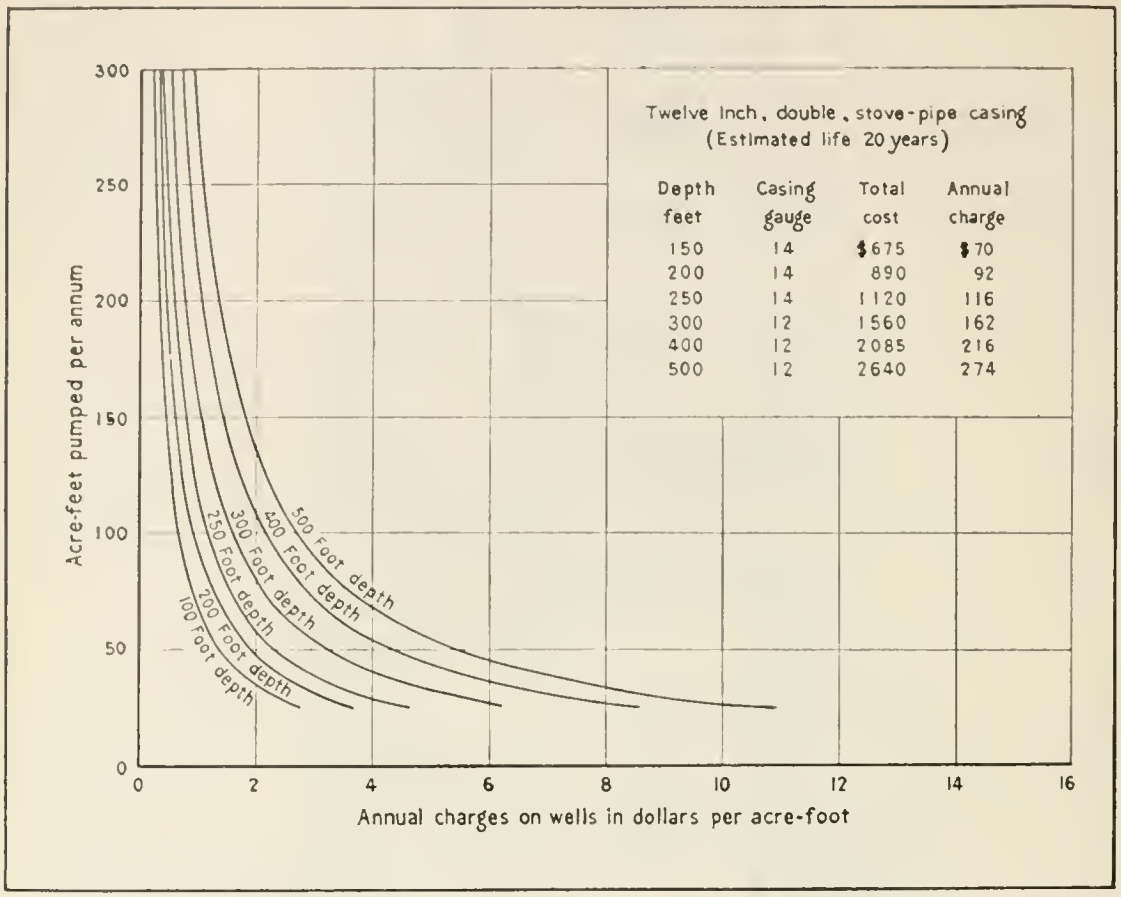
[1] Including $0.42 per acre, assessment and interest on 20 shares Bliss Ditch stock; two irrigations of gravity water received.

TABLE 56

COST OF WATER TO IRRIGATORS ON SEVEN FARMS SUPPLIED EXCLUSIVELY BY FARM PUMPING PLANTS, TULE RIVER—DEER CREEK AREA, EXCEPTING FOOTHILL CITRUS BELT, 1929

Number	Location	Area and crops irrigated		Cost of water to irrigators per acre	Principal items making up cost of water				Number of pumps	Total connected load in horsepower	Approximate lift in feet
		Total area in acres	Crops		Power	Estimated repairs and lubricants	Estimated depreciation	Interest and taxes			
1	4 miles south, 3 miles west, Tipton	245	Alfalfa, 100; cotton, 75; grapes, 70	$11 00	$6 03	$0 54	$1 25	$2 65	2	45	82-93
2	8 miles east, 4 miles south, Tipton	1,500	Cotton, 650; barley, 410; grapes, 210	7 60	5 26	0 50	0 71	1 13	5	225	110
3	1 mile north, 2 miles east, Woodville	55	Corn, 15; barley, 15; cotton, 5	12 40	6 74	1 57	1 57	2 51	1	15	80
4	1 mile south, 2 miles west, Porterville	82	Cotton	8 70	4 38	1 39	1 14	1 80	1	7 5	40
5	1 mile west, 4 miles north, Tipton	162	Alfalfa, 141; corn, 20	9 60	6 80	0 87	0 83	1 20	2	20	60-70
6	4 miles north, Tipton	488	Alfalfa	12 09	8 34	0 71	1 29	1 75	3	85	80-90
7	1 mile north, Angiola	100	Cotton, 60; barley, 40	6 00	3 82	0 55	0 62	1 03	1	15	40

PLATE VII



ANNUAL CHARGES ON TWELVE-INCH STOVE-PIPE WELLS.

ever, since, as anticipated, variation in pumping lift, crop requirement, installed plant capacity per acre, hours of plant operation per annum, etc., was great, no attempt was made to compare the cost of water in one area with that in another.

In order to show the effect of the pumping lift and the duration of operation on the cost of pumping per acre-foot with a deep well turbine delivering one cubic foot per second (450 gallons per minute) Plate VI has been prepared. The total annual cost of pumping includes interest at 6 per cent, taxes at 1 per cent, and depreciation at 5 per cent on the cost of the deep-well turbine, starting equipment, and housing. Prices which prevailed in the first six months of 1930 were used in computing the capital cost. The annual allowance to cover repairs and lubrication is indicated on the diagram. Power charges were made according to the P–2 schedule of the San Joaquin Light and Power Corporation.

The total annual cost of pumping, including the above items but not the annual charges on the well, was computed for operation periods of 1000 hours per annum and up, the greatest being for 8000 of the 8760 hours which make up the usual calendar year.

The slanting, discontinuous lines on Plate VI show the estimated pumping costs per acre-foot for pumping lifts of from 20 to 240 feet for the indicated hours of operation. Discontinuity results from the necessity of increasing the size of motor, pump head, and starting equipment at intervals as the lift increases. Motor sizes are shown to the right of

the 1000-hour line. A flow of 150 gallons per minute for 1000 hours is equivalent to 82.86 acre feet.

It is interesting to note that if the pumping plant is operated 1000 hours per annum, water can be lifted about 70 feet for approximately $5 per acre foot, but if the operation time is increased to 3000 hours about the same cost per acre-foot can be maintained with a lift of 160 feet. Furthermore, if the pumping lift remains at 70 feet, an increase in the annual operation time from 1000 to 3000 hours will result in a decrease in the estimated cost of pumping (not including an annual charge for use of the well) of from $5 to $2.50 per acre-foot.

Diagrams similar to Plate VI can be prepared for deep-well turbine plants of greater capacity. Under normal conditions the unit cost of pumping decreases as the capacity of the plant increases.

Plate VII shows the annual charge per acre-foot of water pumped from 12-inch stove pipe wells of from 150 to 500 feet in depth. The total costs set forth on the diagram include drilling, casing, and perforating. The normal life of a well was taken at 20 years, 3.36 per cent of the cost being set aside annually to provide for replacement from a sinking fund earning 4 per cent per annum. Interest was charged at the rate of 6 per cent and an additional 1 per cent was allowed for taxes.

By combining costs given in both diagrams, an estimate of the total cost of pumping with a deep well turbine of 450 gallons per minute capacity may be obtained. For instance, assuming a lift of 150 feet, an operating period of 2000 hours, and a well depth of 400 feet:

Volume of water pumped—2 × 82.86—166 acre-feet.	
From Plate VI, cost of pumping per acre-foot, not including charges on well	—$6.00
From Plate VII, annual charge on well per acre foot	— 1.30
Total estimated cost of pumping per acre foot approximately	—$7.30

PUBLICATIONS

DIVISION OF WATER RESOURCES

PUBLICATIONS OF THE

DIVISION OF WATER RESOURCES

DEPARTMENT OF PUBLIC WORKS

STATE OF CALIFORNIA

When the Department of Public Works was created in July, 1921, the State Water Commission was succeeded by the Division of Water Rights, and the Department of Engineering was succeeded by the Division of Engineering and Irrigation in all duties except those pertaining to State Architect. Both the Division of Water Rights and the Division of Engineering and Irrigation functioned until August, 1929, when they were consolidated to form the Division of Water Resources.

STATE WATER COMMISSION

First Report, State Water Commission, March 24 to November 1, 1912.
Second Report, State Water Commission, November 1, 1912, to April 1, 1914.
*Biennial Report, State Water Commission, March 1, 1915, to December 1, 1916.
Biennial Report, State Water Commission, December 1, 1916, to September 1, 1918.
Biennial Report, State Water Commission, September 1, 1918, to September 1, 1920.

DIVISION OF WATER RIGHTS

*Bulletin No. 1—Hydrographic Investigation of San Joaquin River, 1920–1923.
*Bulletin No. 2—Kings River Investigation, Water Master's Reports, 1918–1923.
*Bulletin No. 3—Proceedings First Sacramento-San Joaquin River Problems Conference, 1924.
*Bulletin No. 4—Proceedings Second Sacramento-San Joaquin River Problems Conference, and Water Supervisor's Report, 1924.
Bulletin No. 5—San Gabriel Investigation—Basic Data, 1923–1926.
Bulletin No. 6—San Gabriel Investigation—Basic Data, 1926–1928.
Bulletin No. 7—San Gabriel Investigation—Analysis and Conclusions, 1929.
*Biennial Report, Division of Water Rights, 1920–1922.
*Biennial Report, Division of Water Rights, 1922–1924.
Biennial Report, Division of Water Rights, 1924–1926.
Biennial Report, Division of Water Rights, 1926–1928.

DEPARTMENT OF ENGINEERING

*Bulletin No. 1—Cooperative Irrigation Investigations in California, 1912–1914.
*Bulletin No. 2—Irrigation Districts in California, 1887–1915.
Bulletin No. 3—Investigations of Economic Duty of Water for Alfalfa in Sacramento Valley, California, 1915.
*Bulletin No. 4—Preliminary Report on Conservation and Control of Flood Waters in Coachella Valley, California, 1917.
*Bulletin No. 5—Report on the Utilization of Mojave River for Irrigation in Victor Valley, California, 1918.
*Bulletin No. 6—California Irrigation District Laws, 1919 (now obsolete).
Bulletin No. 7—Use of water from Kings River, California, 1918.
*Bulletin No. 8—Flood Problems of the Calaveras River, 1919.
Bulletin No. 9—Water Resources of Kern River and Adjacent Streams and Their Utilization, 1920.
*Biennial Report, Department of Engineering, 1907–1908.
*Biennial Report, Department of Engineering, 1908–1910.
*Biennial Report, Department of Engineering, 1910–1912.
*Biennial Report, Department of Engineering, 1912–1914.
*Biennial Report, Department of Engineering, 1914–1916.
*Biennial Report, Department of Engineering, 1916–1918.
*Biennial Report, Department of Engineering, 1918–1920.

* Reports and Bulletins out of print. These may be borrowed by your local library from the California State Library at Sacramento, California

DIVISION OF WATER RESOURCES

Including Reports of the Former Division of Engineering and Irrigation

*Bulletin No. 1—California Irrigation District Laws, 1921 (now obsolete).
*Bulletin No. 2—Formation of Irrigation Districts, Issuance of Bonds, etc., 1922.
Bulletin No. 3—Water Resources of Tulare County and Their Utilization, 1922.
Bulletin No. 4—Water Resources of California, 1923.
Bulletin No. 5—Flow in California Streams, 1923.
Bulletin No. 6—Irrigation Requirements of California Lands, 1923.
*Bulletin No. 7—California Irrigation District Laws, 1923 (now obsolete).
*Bulletin No. 8—Cost of Water to Irrigators in California, 1925.
Bulletin No. 9—Supplemental Report on Water Resources of California, 1925.
*Bulletin No. 10—California Irrigation District Laws, 1925 (now obsolete).
Bulletin No. 11—Ground Water Resources of Southern San Joaquin Valley, 1927.
Bulletin No. 12—Summary Report on the Water Resources of California and a Coordinated Plan for Their Development, 1927.
Bulletin No. 13—The Development of the Upper Sacramento River, containing U. S. R. S. Cooperative Report on Iron Canyon Project, 1927.
Bulletin No. 14—The Control of Floods by Reservoirs, 1928.
*Bulletin No. 15—California Irrigation District Laws, 1927 (now obsolete).
Bulletin No. 15—California Irrigation District Laws, 1929 Revision.
Bulletin No. 19—Santa Ana Investigation, Flood Control and Conservation (with packet of maps), 1930.
Bulletin No. 20—Kennett Reservoir Development, an Analysis of Methods and Extent of Financing by Electric Power Revenue, 1929.
*Bulletin No. 21—Irrigation Districts in California, 1929.
Bulletin No. 21-A—Report on Irrigation Districts in California for the Year 1929, 1930.
Bulletin No. 22—Report on Salt Water Barrier (two volumes), 1929.
Bulletin No. 23—Report of Sacramento-San Joaquin Water Supervisor, 1924–1928.
Bulletin No. 24—A Proposed Major Development on American River, 1929.
Bulletin No. 28-A—Industrial Survey of Upper San Francisco Bay Area, 1930.
Bulletin No. 31—Santa Ana River Basin, 1930.
Bulletin No. 32—South Coastal Basin, a Cooperative Symposium, 1930.
Bulletin No. 34—Permissible Annual Charges for Irrigation Water in Upper San Joaquin Valley, 1930.
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COOPERATIVE AND MISCELLANEOUS REPORTS

*Report of the Conservation Commission of California, 1912.
*Irrigation Resources of California and Their Utilization (Bul. 254, Office of Exp. Sta. U. S. D. A.), 1913.
*Report, State Water Problems Conference, November 25, 1916.
*Report on Pit River Basin, April, 1918.
*Report on Lower Pit River Project, June, 1918.
*Report on Iron Canyon Project, 1914.
*Report on Iron Canyon Project, California, May, 1928.
*Sacramento Flood Control Project (Revised Plans), 1921.
Report of Commission Appointed to Investigate Causes Leading to the Failure of St. Francis Dam, 1928.
Report of the Joint Committee of the Senate and Assembly Dealing With the Water Problems of the State, 1929.

PAMPHLETS

Rules and Regulations Governing the Supervision of Dams in California, 1929.
Water Commission Act with Latest Amendments Thereto, 1929.
Rules and Regulations Governing the Appropriation of Water in California, 1929.
Rules and Regulations Governing the Determination of Rights to Use of Water in Accordance with the Water Commission Act, 1928.
Tables of Discharge for Parshall Measuring Flumes, 1928.
General Plans, Specifications and Bills of Material for Six and Nine Inch Parshall Measuring Flumes, 1932.

* Reports and Bulletins out of print. These may be borrowed by your local library from the California State Library at Sacramento, California.

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